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THE EFFECTS OF EMG BIOFEEDBACK AND AUTOGENIC TRAINING ON ANXIETY CONTROL AND PERFORMANCE OF AVIATION PILOTS

by

© JAMES WESLEY BARTON

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled THE EFFECTS OF EMG BIOFEEDBACK AND AUTOGENIC TRAINING ON ANXIETY CONTROL AND PERFORMANCE OF AVIATION PILOTS, submitted by JAMES WESLEY BARTON in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Physical Education.

DEDICATION

To my parents for their understanding and encouragement.

ABSTRACT

The primary purpose of this study was to investigate the effects of EMG biofeedback and autogenic training techniques on control of anxiety and to identify any enhancement of motor performance such a reduction in anxiety may produce.

Twenty-four aviation pilots were blocked on scores obtained from Spielberger's State Anxiety Inventory and randomly assigned to three treatment groups. Before and after therapy to reduce anxiety, subjects were tested on six dependent variables: Spielberger's A-Trait and A-State Anxiety Inventories, EMG, EKG, and two flight performance variables (timing and flight accuracy). The left forearm flexor and the frontalis muscle were used as EMG monitoring sites (Basmajian, 1979).

A three-way ANOVA with repeated measures indicated a significant reduction in A-State anxiety scores and EMG scores for both the EMG biofeedback treatment group and the autogenic treatment group, but no significant anxiety reduction in the control group. A three-way ANOVA with repeated measures indicated that a significant EMG decrement occurred during the biofeedback training sessions. No significant improvement in performance was shown for any of the three treatment groups.

It would appear that EMG biofeedback focusing on awareness and control of muscle tension is more effective in producing anxiety decreases than autogenic training procedures. Using EMG feedback to develop increased awareness of changes in muscle tension levels and to establish a skill for muscle tension control appears to be sufficient to produce significant anxiety decreases in a demanding motor performance situation.

Modifications of the experimental design such as a time series analysis within subject's design were suggested as ways to increase the ability to detect the effects of anxiety therapy on performance. Reasons for the lack of change in performance were discussed.

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Chapter 1

INTRODUCTION

Anxiety is a central construct in most forms of demanding performances where, unless effective coping mechanisms are enacted, a debilitating effect upon performance results (Fenz, 1976).

Performance anxiety occurs when environmental cues signal the approach of threatening events which may increase the probability of failure. Thus, these upsetting events usually heighten psychological anxiety because they produce uncertainty in and barriers towards adequate performance preparation. The reaction of an individual to a threatening event has both physiological and psychological characteristics. The physiological features are expressed in autonomic arousal. The psychological characteristics attempt to interpret the handling of threatening events. Since the reaction to psychological stresses varies between individuals, performance may also vary. Fenz (1976) suggested that it is the ability to cope with the situation that will determine the quality of the performance. Recently this phenomena has begun to receive considerable scholarly interest. This is primarily due to a growing inability of many individuals to cope effectively with the stressors associated with increased demand for higher levels of quality motor performances. As a result, much attention has been focused on the development of effective anxiety treatment programmes. Biofeedback and autosuggestive training procedures represent two such treatment programmes

which focus on the use of cognitive coping skills as anxiety combatants.

OVERVIEW

> Biofeedback is a scientific tool for manipulating, and thereby studying, physiological processes so as to explore the nature of their relationships with other such processes and their association with specific environmental and behavioral conditions (Schwartz, 1977:17).

Biofeedback training allows an individual to learn self-control of physiological activity from fed back biological information. The underlying assumption is that when a person has accurate information about a bodily function, such as muscle tension level, he can learn to control it (Karlins and Andrews, 1972; Miller, 1978). When treating anxiety, electromyographic feedback is usually used to provide information about muscle tension levels and to teach relaxation. The goal of therapy is to increase personal awareness of muscle tension levels, and to train personal relaxation skills. When training is complete the person is able to produce his newly acquired relaxation response whenever he begins to feel anxious.

Current theorists in the area of biofeedback research vary considerably in their theoretical positions when explaining the acquisition of biofeedback skills. Three distinct theoretical conjectures seem to emerge. The initial conjectural hypothesis was proposed by Budzynski (1973) who utilized an information theory perspective to explain the underlying processes of biofeedback. A second position taken was the behavioural approach proposed by Karlins and Andrews (1972), and Wolpe (1970). This operant conditioning approach to systematic behavioural control was first advocated by Skinner (1953) who held that the repetition

of reinforced responses gradually become a habitual response pattern which cause the progressive diminution of the unadaptive response pattern. For example, an individual seeking biofeedback training to diminish anxious responses to threatening stimuli might utilize electromyographical (EMG) feedback in order to aid in learning deep relaxation, a response that is incompatible with anxiety. Once the individual learns muscular relaxation and is capable of replacing muscular tension with a relaxation response, a progressive diminution of the tendency to respond anxiously will occur. It is through repetition that the habitual anxiety response pattern is gradually replaced by a more adaptive relaxation response pattern.

Meichenbaum (1976:77) offered a third, cognitive approach for the biofeedback process. He stated:

> Biofeedback training ultimately occurs on a cognitive level, resulting in change in the subject's perceptions, attributions, appraisals and his internal dialogue about his ability to control his own physiological responses, cognitions, feelings and behaviors.

The cognitive theorists believe man to be an evaluating being who is endowed with cognitive appraisal mechanisms. When these mechanisms become distorted, perceived anxiousness causes physiological cues which increase anxiety level. Biofeedback offers a means of awareness of the physiological cues which increase anxiety level. Biofeedback offers a means of awareness of the physiological cues which would train the individual to learn to evaluate his cognitive reaction to his physiological responses and produce a more adaptive response.

Lazarus (1977) advanced the concept of "cognitive appraisal" to characterize the psychological context of the emotion arising from adaptive transactions between the individual and the environment.

Cognitive appraisal expresses the evaluation of the significance of a transaction for the person's well being and the potentials for mastery in the continuous and constantly changing interplay between the person and the environmental stimulus configuration (Lazarus, 1977:15).

Autosuggestive training is a general therapeutic method of which autogenic relaxation cônstitutes one approach. Autogenic relaxation was first introduced by Schultz (1969) who promoted a psychophysiological approach to psychotherapy in the form of autogenic training. Both Schultz and Luthe (1969) fostered a growth of concern in the area of anxiety reduction as had Edmund Jacobson (1939) who employed progressive relaxation techniques. The basic idea behind autosuggestive relaxation is that by attending to verbal cues one is instructed to relax specific areas of the body. The verbal cues are intended to relieve tension and anxiety manifested as neuromuscular innervation. This technique should not be confused with systematic desensitization (Wolpe, 1958) where a counteracting emotion is reinforced in order to overcome an undesirable emotional habit step by step.

The present study investigates the effectiveness of EMG biofeedback and autogenic training techniques as they relate to an effective reduction in anxiety and an enhancement of motor performance skills in aviation pilots. Anxiety level was assessed using both self-report and physiological measures, while performance was assessed by an aviation instructor using a flight simulator performance monitoring system. EMG biofeedback was presented through instrumentation which provided accurate feedback information on varying levels of bodily muscular tension. Autosuggestive relaxation was provided in the form of an auto-

genic relaxation cassette tape (Budzynski, 1977) designed both to induce a state of relaxation and to distinguish between relaxation and bodily tension.

This thesis is divided into five sections. In the first chapter, an overview of the problem of the study is given. The basic terminology is reviewed as well as the importance and need for this study given. In Chapter 2, a review of the literature and treatment considerations are outlined. In the third chapter, the experimental design is discussed and procedures are outlined. In Chapter 4, the data analysis is presented and discussed. The fifth chapter contains the conclusions and implications arising from this study and some directions for future research.

NEED FOR THE STUDY

In view of the research on performance anxiety (Suinn, 1977a), it seems apparent that an understanding of effective coping mechanisms is necessary in order to deal with specific environmental and behavioural conditions which may affect optimal motor performances.

The application of biofeedback techniques for the enhancement of motor performance is receiving serious attention by a growing number of sports-minded counsellors, physical educators, psychologists and physicians. It is becoming more evident that under demanding motor performance conditions, psychological factors and subsequent psychophysiological response patterns are as relevant to performance as physical readiness. As a result, researchers and practitioners have begun utilizing biofeedback and relaxation training for the purpose of anxiety and stress

reduction.

Biofeedback training has been applied, with apparent success, to stress management (Bernthal and Papsdorf, 1977; Canter, Kondo, and Knott, 1975; Raskin, Johnson, and Rondestuedt, 1973) and to the treatment of a host of stress-related disorders, including essential hypertension (Datey, 1976), migraine headaches (Friar and Beatty, 1976), Raynaud's Syndrome (May and Weber, 1976), tension headaches (Budzynski and Stova, 1973), stuttering (Guitar, 1975), hyperkinesis (Braud, 1978) and subvocalization (Arrons, 1971). In general, feedback systems operate on their ability to detect changes in the environment of their operation, and to make the necessary internal adjustments so that functions remain both optimal and continuously appropriate to the demands of their environment (Brown, 1974).

Research on biofeedback has provided encouraging results with respect to anxiety control. However, a variety of methodological flaws have slightly retarded research progress (Miller, 1978). Inconsistency of results is mainly attributed to non-specificity of training procedures, no control group, small samples and inadequate research designs (Blanchard and Young, 1974).

The present research study was designed to address the types of issues raised above and to attempt to provide directions for further research in the area of performance anxiety. The design permitted comparisons between EMG biofeedback training and autogenic relaxation training in treatment effectiveness on performance anxiety in the form of muscular tension. In addition to further studying the effects of anxiety on motor performance in general and aviation in

particular, this study also attempts to contribute to furthering the understanding of anxiety treatment in human motor performances.

STATEMENT OF THE PROBLEM

The basic proposition to be tested in this study was that EMG feedback and autogenic relaxation training would be effective techniques for the reduction and control of aviation pilots' anxiety and therefore would facilitate an increase in motor performance. A number of directional hypotheses derived from the literature are to be tested:

1. Pilots receiving treatment in the form of EMG biofeedback and autogenic relaxation training will experience an anxiety decrement, as measured by state anxiety scores, muscle tension and heart rate, as compared to pilots receiving no relaxation training.

2. Pilots receiving EMG biofeedback training will experience a greater anxiety reduction than pilots receiving autogenic training or no treatment (control).

3. Pilots receiving autogenic relaxation training will experience a greater anxiety reduction than pilots receiving no treatment.

4. Pilots receiving EMG biofeedback and autogenic training will show greater improvement in the quality of performance than pilots receiving no relaxation training.

5. High anxious pilots will experience a greater decrement in performance anxiety (as measured by state anxiety, EMG and EKG) and thus show a greater improvement in flight performance than low anxious pilots.

DEFINITION OF TERMS

Anxiety - autonomic response pattern characteristic of a particular individual organism after the administration of a noxious stimulus (Wolpe, 1958).

Autonomic Arousal - the extent of release of potential energy stored in the tissues of an organism, as evidenced in activity or response (Duffy, 1962). A subject's arousal level in this study is operationally defined by deviations in heart rate and muscle tension from a resting level.

Biofeedback - a technique which uses instrumentation to give a person immediate and continuing signals on change in a bodily function of which one is not usually conscious (Sullivan, 1975).

Electromyography - a recording of the changes in electrical potential of a muscle by means of surface electrodes (Basmajian, 1974).

Emotions - complex, qualitatively different, feeling states or conditions of the human organism that have both phenomenological and physiological properties (Drever, 1968).

Heart Rate - changes in electrical potential of cardiac muscle by means of surface electrodes.

Muscle Tension - an increased state of muscular contraction over and above that required by bodily function and mechanical work.

Performance - the quality of motor response in a single engined flight simulator as measured by a flight instructor.

Relaxation - a decreasing state of muscular tension as measured by a decrease in EMG (microvolts).

State Anxiety - a transitory emotional state of the human organism that varies in intensity and fluctuates over time or situation (Spielberger, 1972).

Surface Electrodes - silver discs, connected to an amplifier, that are placed on the surface of the skin for the purpose of recording muscle action potentials (Basmajian, 1974).

Trait Anxiety - relatively stable individual differences in anxiety proneness (Spielberger, 1972).

Chapter 2

REVIEW OF LITERATURE

THE CONSTRUCT OF ANXIETY

Anxiety is a broad abstraction, a hypothetical entity which has no actual physical existence, but which has proven useful in explaining observable behavioural phenomena (Levitt, 1967). Spielberger (1975) claimed that much of the ambiguity and confusion in anxiety research seems to arise from the indiscriminate use of the word. This lack of consistency in explicitly describing the manner in which the construct of anxiety is used raises concern (Cattell, 1972; Lazarus and Averill, 1972; Spielberger, 1975; Wolpe, 1970). The important consideration for future research seems to lie in explicitly defining the operational criteria which are used to delineate the concept of anxiety. This explicitness would permit theorists to compare their substantive definitions in order to determine "whether anxiety as studied by one author has any relation to what is being studied by another" (Lazarus and Averill, 1972:267).

The range of possible definitions is, in principle, unlimited, and in practice, very broad. Levitt (1967:69) stated:

> one could go forever in this absurd fashion, adding word after word and phrase after phrase in a vain attempt to define the original, single-word construct. Even if the volume of verbiage becomes infinite, we shall not have added much more clear meaning to the word with which we began . . . .

A further complication arises in the way one views the anxiety concept. Some theorists (Cattell, 1972; Levitt, 1967; Spielberger, 1975) viewed anxiety as a hypothetical construct while others (Mahoney, 1977; Wolpe, 1970) viewed anxiety as an intervening variable. In order to understand the present author's conceptualization of anxiety, an outline of the contributing theoretical positions and the ideas that resulted in the conceptualization of anxiety will be presented.

THEORETICAL PERSPECTIVES

It is generally agreed that anxiety is both psychological and physiological in nature, but the relative stress placed on each aspect varies with the orientation of the theorist. Freud (1936:19) emphasized the psychological nature of anxiety when he stated that "it is in the first place something felt." In yet another approach, Wolpe (1958:76) focused on the physiological facet of anxiety by defining it as "the autonomic response pattern or patterns that are characteristically part of the organism's response to noxious stimuli." On the other hand, Eysenck (1969) pointed out inherited differences in the neurophysiological structure of the visceral brain to account for individual differences in this personality variable.

Wolpe (1973) believed that anxiety is conditioned to environmental stimuli and emphasized the importance of the learned behavioural characteristics of an anxiety response rather than the drive reduction characteristics. According to Wolpe (1958), as drive states arise they excite overt action. If the resulting behaviour is adaptive, the drive

state is dissipated. If the resulting behaviour is unadaptive, the excitement is sustained, and becomes labelled anxiety. The behavioural orientation tends to view anxiety as a group of conditioned responses that an organism makes under certain stimulus conditions (Wolpe, 1973). Cognitive researchers suggest that behaviour is based on the perception, not just the occurrence, of environmental situations (Schacter, 1966). Meichenbaum (1975) envisioned two main constituents of anxiety: emotionality, characterized by heightened arousal, and worry, characterized by self-degenerating thoughts and undue concern over performance. Because of the attention it demands, worry interferes with performance, even though heightened arousal could be facilitative. A perceived arousal state that becomes labelled anxiety is usually followed by feelings of personal inadequacy which increases the anxiety level. In this way, the very perception of a rising level of anxiety produces more anxiety (Meichenbaum, 1976).

Ellis (1973) also held that a person's emotional or behavioural reaction in a situation is primarily the result of the person's cognitive appraisal of the situation, rather than the specific situational stimuli.

One of the important issues regarding personality in general, and anxiety in particular, is the controversy as to whether traits, situations, or the interaction of both are the major source of behavioural variance.

Several authors (Cattell, 1946; Cattell and Scheier, 1961; Freud, 1936; McClelland, 1951; Murray, 1938; Rappaport, 1945) contended that traits or personality variables manifested in terms of cross-situational consistencies are the major determinants of behaviour. This viewpoint emphasizes intrapsychic or dispositional constructs and concludes that individuals react

to all types of threatening situations in more or less the same way.

Mischel (1968, 1969, 1971) and Vernon (1964) have criticized the trait approach to personality. Mischel (1971:74) emphasized that "a person will behave consistently across situations only to the extent that similar behaviors lead, or are expected to lead, to similar consequences across these conditions." Alker (1972:12) suggested that "personality variables can explain people's behavior even though that behavior varies from situation to situation." Endler (1973:296) reported that "cross-situational consistency versus the situational specificity controversy may be a pseudo issue, leading to much misguided research." Endler (1973) believed the appropriate research question to be, "How do individual differences and situations interact in determining behavior?" Endler (1962) proposed a person-situation interaction model for anxiety which is basically derived from both the rationale and research regarding the S-R Inventory of Anxiousness. Endler (1966) concluded that personality description and assessment would be improved by describing the kinds of responses that people make in a variety of situations. The S-R Inventory of Anxiousness sampled responses, situations and individual differences separately to determine the relative variance contributions of each of these factors individually and in interaction with one another.

The conceptualization of anxiety for the present study falls within the cognitive perspective. Anxiety is viewed as a hypothetical construct associated with an unpleasant, interfering emotional state recognized by increases in physiological arousal.

APPLICATION OF ELECTROMYOGRAPHICAL (EMG) FEEDBACK

Speilberger (1972:29) suggested that "the presence of anxiety states in humans can be most meaningfully . . . defined in terms of some combination of introspective verbal reports and physiological-behavioral signs." A number of investigators appeared to share Spielberger's view, because it is not an uncommon practice for experimenters to simultaneously employ self-report and physiological indicators of anxiety (Basmajian, 1979; Payne, 1970; Reinking and Kohl, 1975). Anxiety-inducing stimuli cause an increased activity in the sympathetic nervous system which invariably causes a number of physiological responses to occur, such as increased hepatic and muscle glycogenolysis, increased breakdown of triglycerides to glycerol and fatty acids to promote energy production, increased central nervous system alertness, increased skeletal muscle contractility, increased cardiac output, increased contractility and venous return, shunting of blood from the viscera to skeletal muscles, increased ventilation, increased coagulability of blood, increased pupilary dilation, peripheral vasoconstriction and piloerection (Budzynski, 1973; Germana, 1969; Vander, 1975). A particular physiological response may vary in intensity and specificity from individual to individual. However, it is generally agreed that increased muscle tension, heart rate and respiration rate are some of the most commonly recognized components of an anxiety reaction (Budzynski, 1973; Malmo, 1975). Budzynski (1973:537) further stated that "these anxiety reactions are more or less autonomous in that they occur automatically and are often below the individual's level of awareness." Malmo (1975:12) explicitly pointed out that "overactivation of the skeletal musculature is clearly involved in chronic anxiety." Therefore,

it may be reasoned that the number of muscle fibers recruited and their frequency of discharge determine the tension in a muscle, an indication of the tension so produced may be obtained by integrating the electrical potentials set up by the motor units. The integration gives a relative expression of the number of muscle fibers active in a given situation and can be used as an optional measure of muscle activity (Vredenbregt, 1973). These electrical changes may be picked up by electrodes placed on the skin surface or embedded in the muscle, amplified, and recorded photographically or mechanically (Ralston, 1961).

Bayer and Flechtenmacher (1950) appeared to have been the first to describe clearly the parallelism between tension and amplitude of the electromyogram in a muscle voluntarily contracted of a fixed length (isometric contraction). Lippold (1952) made similar observations showing that when a voluntary isometric contraction of muscle is made, the electrical activity, measured by integrating the action potentials from surface electrodes, bears a linear relation to the tension that is being exerted; and consequently, the greater the tension, the greater the motor unit recruitment (Henneman, 1965). At this point it is important to understand that enhancement of neuromuscular activity in a muscle causes contraction of that muscle while abolition of neuromuscular activity in a muscle causes relaxation of that muscle.

Basmajian (1974) reported that electromyograms from normal human muscles generally show that relaxation occurs completely and almost instantaneously when subjects are ordered to relax. In this situation, the relaxing individual is psychologically impeding electrical stimulation to body musculature. However, a normal person does not completely relax all his muscles at once. Reacting to multiple internal and external stimuli,

various groups of muscles show increasing and decreasing amounts of activity. Goldstein (1965) found that certain muscles at rest among anxious subjects showed electromyogram activity related to a general muscular tension, these muscles were mostly in the shoulder girdle and neck regions. Anxious subjects also showed a marked increase in muscular contraction when exposed to new stimuli.

Sherrington (1965) referred to the inability to fully relax as a state of muscular inhibition where he pointed out cases of nervous abnormality and spasticity of paraplegia.

Smith (1934) proposed the possibility of conscious control and training of single motor units. However, little progress was made in this area until the early 1960's when more efficient technology and systematic studies began. Currently, electromyography technology is rapidly changing. The conventional surface and insert (needle) electrodes are being more precisely refined. However, various arguments are presented in the literature as to the usefulness of EMG in terms of its quantitative relationship to the muscle activity.

When there is complete relaxation of the muscles, no action potentials are present. This statement has been generally agreed upon (Basmajian, 1962; Johnson, 1960; Joseph, 1964). With increasing effort, more motor units are called into play and the frequency of the unit's discharge is increased. Thus, the amplitude of the EMG recording should parallel that of the mechanical response. However, it has been stated (Johnson, 1960) that EMG measures only the electrical events associated with excitation, and is thus only an indirect measure of contraction. According to Loofbourrow (1960), EMG amplitude and mechanical response are essentially parallel, with the possible variation occurring due to

the influence of fatigue.

EMG biofeedback training has more aptly been termed single motor unit training, which offers a useful approach to studies of the conscious control over spinal motoneurons, of the neurophysiological processes underlying proprioception and feedback, and of many psychophysiological phenomena (Basmajian, 1974).

Individuals undergoing motor unit training are given auditory and visual displays of their individual myoelectric potentials recorded by means of intramuscular or surface electrodes. The cues provide the individual with an awareness of the twitching of individual motor units. Feedback cues provide the mode from which motor unit control is learned (Basmajian, 1963).

Green (1969), using a modification of the single motor unit training technique, suggested that EMG biofeedback training would be useful in many situations.

Mathews and Gelder (1969) studied the effects of single motor unit training on deep muscle relaxation. A non-postural muscle, the frontalis muscle, was chosen for the site of EMG feedback. It was discovered that through forehead EMG feedback, the subject could learn to eliminate residual tensions from the jaw muscles, and even throat and tongue musculature, thus promoting deep relaxation.

Dixon and Dickel (1967) first drew attention to the idea that EMG indicates that tension headache is accompanied by 'fatigue contracture' of traumatized cranio-cervical muscles. They showed a significant correlation between musculator over-activity in frontalis and neck muscle and the frequency of tension headaches.

Budzynski and Stoyva (1969) while working at the University of

Colorado Medical Centre, conducted programmes for tension headache patients who were trained to produce low frontalis muscle EMG levels through biofeedback training and significantly reduced the occurrence of tension headaches in all patients treated.

Wilson and Wilson (1970) used EMG to monitor the subject's level of muscular tension at different body sites in order to identify areas of abnormally high muscular tension. EMG biofeedback was then used to reduce muscular trauma and therefore enabled the subject to maintain a more relaxed, lower anxiety state.

The use of electromyographical feedback has been used in a variety of additional applications ranging from muscle retraining among hemiplegic patients (Lee, 1976) to laryngeal muscle training to overcome subvocalization movements of slow readers (Hardyck, 1966; McGuigan, 1970; Shimazu, 1970; Sussman, 1972). However, a paucity of research exists in the application of electromyographical feedback in the area of motor performance enhancement among normal populations.

Anxiety and Performance

In the area of anxiety management and motor performance, many researchers subscribe explicitly to the "inverted U hypothesis" or the Yerkes Dodson Law (Duffy, 1962; Malmo, 1966; Martens, 1970, Oxendine, 1970). The theory assumes an optimal physiological activation of the organism for optimal performance. The more one's physiological activation deviates either way from this optimal point, the more performance decreases. According to this theory, performance either increases or decreases as the subject's anxiety increases, depending on the complexity of the task, the degree of stress under which the subject operates, and whether or

not one is performing a learned or unlearned task. However, one should not infer that autonomic changes will occur in a similar pattern for all individuals (Lacey, 1950). Each individual's somatic response pattern is specific to the situation (Lacey, 1967). Therefore, individual difference must be considered in research pertaining to the relationship between optimal physiological arousal and optimal performance.

Spielberger (1966) believed that many serious methodological deficiencies regarding the measurement of pre-performance anxiety in early studies resulted in error. He contended that the conceptual status of anxiety has been muddled by a failure to distinguish between state and trait anxiety. According to Spielberger (1966:17):

> Anxiety states are characterized by subjective, consciously perceived feelings of apprehension and tension, accompanied by or associated with activation or arousal of the autonomic nervous system.

Trait anxiety, on the hand, was described by Spielberger (1966:17) as:

> a motive or acquired behavioral disposition that predisposes an individual to perceive a wide range of objectively non-dangerous circumstances as threatening and to respond to these with state anxiety reactions disproportionate in intensity to the magnitude of the objective danger.

In Spielberger's conception of anxiety, A-State is characterized primarily by the intensity of anxiety as an emotional state at a particular moment in time, whereas A-Trait is characterized primarily by the frequency with which an individual experiences anxiety states. Spielberger (1966) observed that persons who are high A-Trait are particularly threatened in situations which pose direct or implied threats to self-esteem. Since

these individuals were persons who fear failure, it might be expected that they will manifest higher levels of A-State in situations that involved psychological threats to self-esteem rather than physical danger.

According to Cratty (1973), and Oxendine (1970), the optimum level of arousal varies with the particular motor task. Different tasks require different levels of arousal for the most effective performance. In addition, the optimum arousal state varies from person to person. For example, high anxiety versus low anxiety, extraversion versus introversion, and experience versus non-experience are some of the individual variables making it difficult to establish definitive guidelines for all persons.

The following generalizations are offered on the arousal-performance topic based on research evidence (Oxendine, 1970):

1. A high level of arousal is essential for optimal performance in gross motor activities involving strength, endurance and speed (i.e., pushups).

2. A high level of arousal interferes with performance involving complex skills, fine muscle movements, coordination, steadiness, and general concentration (i.e., archery).

3. A slightly-above average level of arousal is preferable to a normal or sub-normal arousal state for all motor tasks.

It has been suggested by many leading sports psychologists (Cratty, 1973; Martens, 1970; Oxendine, 1970), regarding performance anxiety, that an optimum level seems to be needed to perform well. However, this optimum level of anxiety is specific to the activity in which one is engaged.

It was suggested by Oxendine (1970) that relatively uncomplicated skills involving primarily strength and endurance are better accomplished during an extremely anxious state than a reduced anxious state. Fine motor skills on the other hand which require a certain amount of dexterity are best served by a less anxious state. Therefore, the effects of anxiety may have an enhancing effect upon performance or a debilitating effect depending upon the level of anxiety, experience and the nature of the activity.

Weinberg and Hunt (1976) attempted to show the interrelationships between anxiety, motor performance and electromyography by investigating the quality of movement that makes up the motor performance instead of focussing on the end result of the performance. It was concluded that high anxious subjects performed less efficiently and expended more neuromuscular energy throughout the performance sequence than low anxious subjects as assessed by the State-Trait Anxiety Inventory and electromyographical readings.

Research has established that the electromyograph, by providing information about muscle tension that individuals cannot normally perceive, can supplement normal proprioceptive mechanisms until they become sensitized sufficiently to provide voluntary control over tension (Basmajian, 1974). A reasonable assumption can be made therefore that EMG biofeedback may be instrumental in reducing tension to a desirable level, which may enhance motor performance and learning.

EMG Biofeedback and Performance

Levy, Jones, and Carlson (1981) investigated the effects of EMG biofeedback on the rehabilitation of motion sickness. Twenty aircrew

of the United States Air Force disabled by chronic severe airsickness underwent biofeedback treatment in order to eliminate the motion sick response. Following treatment, sixteen aircrew were able to return to full flying duties with no airsickness symptoms.

French (1980) investigated the effects of electromyographic feedback on learning and performance of a fine motor skill. Thirty males were tested for hand-eye coordination on a pursuit-rotor tracking task, ranked on performance scores and divided into two experimental groups and a control group. The experimental groups received three hours of EMG biofeedback training and were then retested. Results revealed that EMG biofeedback training significantly reduced muscle tension levels as measured by the electromyograph and significantly improved performance of the motor skill. Blais and Orlick (1977) showed significant reductions in EMG levels from among female athletes involved in figure skating, rowing and water skiing after six sessions of EMG biofeedback training. In another study, Blais (1978) investigated the effects of EMG biofeedback training on sport pre-competitive state anxiety and motor performance among ten to thirteen year old boys. Results showed a significant decrease in state anxiety scores and a significant increase in performance when EMG biofeedback trained subjects were compared with control subjects. Wilson and Bird (1979) conducted a study involving gymnasts to see if EMG biofeedback from the antagonistics muscles would improve hip flexion. It was concluded that EMG biofeedback was a useful modality for improving flexibility in specific muscle groups.

Payton and Kelly (1972) explored fine tuning of muscular control using EMG biofeedback in order to enhance performance of skilled tasks

whose subjects included professional golfers. Results showed a significant decrease in generalized anxiety and a significant increase in the level of performance.

The examination of movements by EMG has greatly enhanced precise muscle functionality, in accordance with certain movement patterns, thereby illustrating precise muscle recruitment patterns for all forms of movement, including synchronization of gait and muscular innervation of walk. Biofeedback gives the learner an ideal muscular recruitment pattern for various performance skills (Basmajian, 1974).

Cognitive Strategies

Wenz and Strong (1977) developed a model known as the "fine tuning model" which viewed the development of athletic performance as progressing through four stages: 1) trial and error; 2) feedback from others; 3) seeing oneself in action; 4) internal self-regulation. The application of several stress management techniques including biofeedback were used in their model in order to effectively facilitate performance in stressfully demanding events.

The use of such cognitive strategies seems to indicate an enhancement in achieving a higher level of motor performance and a more optimal arousal level especially when coupled with EMG biofeedback training.

Suinn (1977) has developed a conceptual model of athletic performance in which he views performance as a function of two major variables, aptitude and skill acquisition. Suinn's model allows the clinician or coach to assess which variables are responsible for controlling the correct response by intervening in the performer's cognitive strategy. Two such cognitive strategies include: i) Visuo-Motor Behavior Rehearsal

(VMBR) which consists of teaching the individual deep muscle relaxation and developing an imaginary scene involving competition while practising, by imagination, the sequence of movements involved; and ii) EMG biofeedback where the individual is provided with information on muscle tension levels while using imagery to develop an imaginary scene involving a required particular motor skill.

Suinn (1972) using alpine ski racers, reported a significant improvement in performance when VMBR trained skiers were compared to a non-trained control group.

Di Caria (1977) found, using the same technique, that intermediate level high school gymnasts were able to improve their performance and reduce anxiety using VMBR, while Kolonay (1977) in a similar study, reported a significant improvement in foul shooting ability among high school basketball players after using VMBR training techniques.

Suinn's research (1977b) in the area of tension control and motor performance seems to indicate that the most significant reduction in tension occurs through the utilization of both visualization techniques and biofeedback.

Nideffer (1978), using attention control training (ACT) and deep muscle relaxation reported a significant decrease in anxiety levels and an increase in performance among sixteen AAU age group scuba divers.

Cognitive research in the area of stress reduction and performance enhancement has provided encouraging results; however, much investigation is still needed to elucidate the performance-enhancing combination.

Chapter 3

METHODS AND PROCEDURES

Aviation pilots were measured on Spielberger's State Anxiety Inventory and divided at the median into two equal groups based on anxiety level. Within the high and low anxiety groups, subjects were assigned randomly to one of three treatment groups: EMG biofeedback, autogenic training and control. Subjects were again measured on Spielberger's State and Trait self-report anxiety inventories (Appendix A) and monitored for physiological responses during the pre-test flight trial. During both flight trials, the performance of each experimental subject was evaluated by a qualified aviation instructor. Following the treatment period, subjects were retested again on the post-test flight trial and flight performance was evaluated. Changes on self-report anxiety, physiological responses, and performance were then compared from among the three treatment groups.

EXPERIMENTAL DESIGN

The experimental design was a randomized block design using a three-factor analyses of variance with repeated measures on the third factor. There were two levels of the first factor, high and low anxiety. The second factor included the three treatment groups: EMG biofeedback, autosuggestive training, and control, which were tested both in the pre- and post-tests. The third factor was time. The dependent variables were

EMG, EKG, flight and time performance, and state and trait anxiety (Appendix B).

THE SUBJECTS

The subjects of the study were twenty-four male volunteer aviation students from Selkirk College, Castlegar, British Columbia. Their ages ranged from eighteen to twenty-three years, the mean age being 21.3 years. Each subject was licensed as a private pilot and enrolled in the second year of a two-year aviation career programme which leads to a commercial licence rating.

All subjects had received comparable flight training and experience.

THE SETTING

All testing and training sessions were carried out at Selkirk College located in Castlegar, British Columbia. Flight testing was performed in the flight simulation room in the Aviation Department.

Each subject was familiar with the test setting since regular flight training took place at that location.

The treatment sessions took place in a private laboratory designed specifically for biofeedback and autosuggestive training.

DEPENDENT MEASURES

Six dependent measures were used in this study: the State-Trait Anxiety Inventory (STAI) (Spielberger, 1960); EKG; EMG; and a mean performance score taken from flight and time performance evaluations.

Physiological measures were monitored by a Cambridge VS4 Portable Electrocardiograph and an Autogenics Systems Inc., 1700 Electromyograph.

Performance was rated by the instructor who used the Frasca 101-G flight simulator's tracking system to provide evaluative data.

Biofeedback treatment included the use of the Autogen 1700 electromyographic feedback unit while autosuggestive treatment included a Sony cassette and tape player.

State-Trait Anxiety Inventory

The State-Trait Anxiety Inventory (STAI) (Appendix A) is a forty-item self-evaluation questionnaire designed to measure and distinguish between stable individual differences in anxiety proneness (A-Trait) and transitory anxiety reactiveness (A-State) (Spielberger, Gorsuch and Lushene, 1970). It is composed of twenty items that ask a subject to respond according to how the person "generally feels" (A-Trait items), and twenty items that ask a subject to respond according to how the person "feels right now" (A-State items). This scale has been used extensively in anxiety research (D'Angelli, 1974; Martuza, 1974; Spielberger, 1975; Townsend et al., 1975) and demonstrates reliability (Kendall, Finch, Auerbach, Hooke and Mikeulka, 1976; Spielberger et al., 1970) and validity (Kendal et al., 1976; Martuza, 1974; Spielberger, 1975; Spielberger et al., 1970).

EKG

EKG data was obtained by means of a Cambridge VS4 Portable Electrocardiograph (Plates 1 and 2). Disposable surface electrodes were attached to three prepared areas of the body: a) the junction of the fourth intercostal space mid-way between the right and

Plate 1. Cambridge VS 4 portable electrocardiograph.

Plate 2. Surface electrode connections for Cambridge VS 4 portable electrocardiograph.

the left sternal border; b) the fifth intercostal space at its intersection with the left mid-clavicular line; c) the fifth intercostal space at its intersection with the right mid-clavicular line. EKG was recorded as a heart rate indicator in beats per minute throughout the entire flight sequence.

EMG

All EMG levels were measured using an Autogenics System Inc., 1700 electromyograph, as illustrated in plates 3 and 4. This unit is capable of accurately monitoring EMG activity changes of .10 microvolts (uv). The main component of the electromyograph is a differential amplifier with low internal noise levels (.10 uv noise). Incorporated into the electromyograph is a band pass filter for the rejection of EEG and ECG artifacts which was set at 100-200 Hz., as recommended by the manufacturer. A four second response averaging mode was used in generating the feedback signal being monitored from surface electrodes attached to both the frontal region (two positive electrodes placed one inch above the eyebrow vertically above the centre of the eye with a ground mid-way between) and the left flexor carpi ulnaris (two positive electrodes placed one-quarter and three-quarters of the way between the lateral epicondyle and the ulnar styloid process with a ground mid-way between).

Silver chloride electrodes were used to detect the muscle action potentials. Biogel biopotential contact medium was used in the cups of the electrodes, which were attached to the skin with adhesive discs.

Plate 3. Autogen 1700 front panel EMG biofeedback unit.

Plate 4. Surface electrode connections for Autogen 1700.

Performance

Individual performances were monitored over both pre-test and post-test trials by a qualified aviation instructor. The Frasca 101-G single engine flight simulator (as illustrated in plates 5 and 6) was used in this study which duplicates an actual single engined aircraft in terms of performance, navigation and flight instrumentation. An attached performance monitoring desk allowed the instructor to monitor an individual's flight performance and provided radio communication with the pilot. Each subject was evaluated on timing and flying performance and was assigned a score out of ten on each parameter.

Physiological monitoring and performance evaluation during flight simulation are illustrated in plates 7, 8 and 9.

Sony Cassette Player and Tape

A standard battery operated Sony cassette player and a commercially available autogenic relaxation tape (Budzynski, 1977) were used for all autosuggestive relaxation sessions.

The autogenic relaxation tape consisted of a single, thirty-minute relaxation session which employed the use of suggestive phrases which were designed to induce bodily feelings of heaviness, warmth, muscle relaxation and general well being in order to promote and teach the subject relaxation skills.

Instructor's Performance Evaluation

Parameters. Each subject was evaluated on timing and flying accuracy and was assigned a score out of ten on each parameter. The nature of the Frasca Simulator Tracking System allowed the instructor

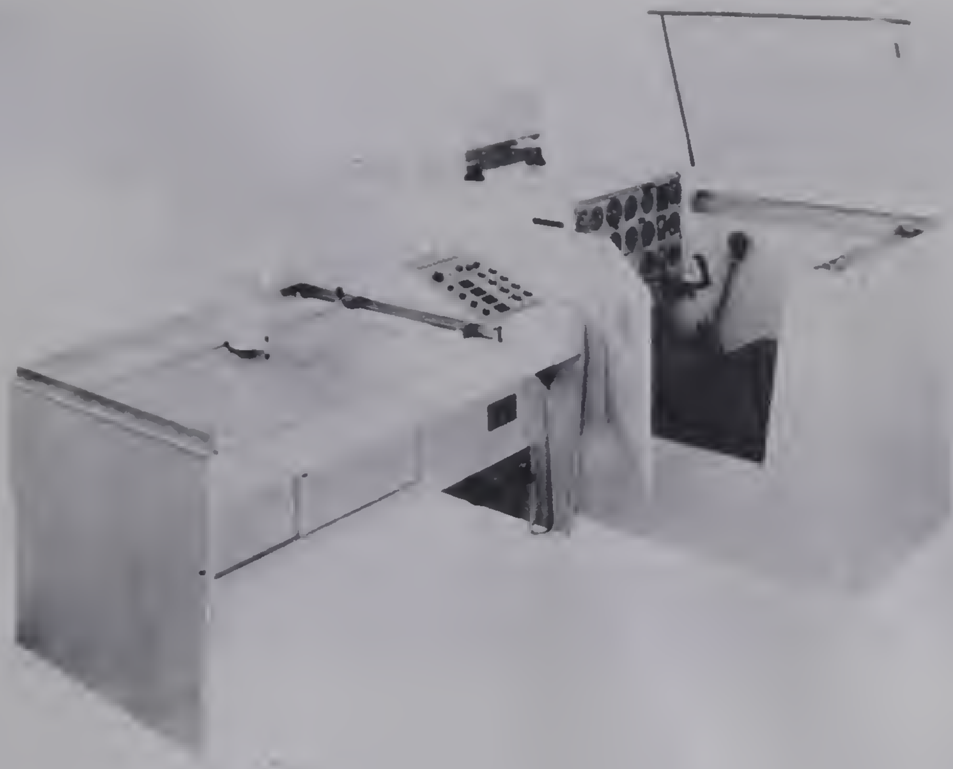

Plate 5. Frasca Model 101-G flight simulator.

Plate 6. Frasca simulator cockpit.

Plate 7. Physiological monitoring and performance evaluation during flight simulation (frontal aspect).

Plate 8. Physiological monitoring and performance evaluation during flight simulation (lateral aspect).

Plate 9. Physiological monitoring and performance evaluation during flight simulation (posterior aspect).

to make extremely accurate evaluations on the subjects' timing and flying performances.

Each subject's score on the timing parameter was based on: a) the number of pre-flight checks accurately made in one minute; b) the number of steep turns made before descending at the five-minute mark; c) the landing time (for every thirty seconds off the seven-minute mark, one score was deducted); d) precision in timing on all instructional signals.

Each subject's score on the flight accuracy was based on staying within flight limitations and pre-established restrictions: a) ± fifty feet in elevation; b) ± five knots in airspeed; c) ± five degree bank on turns; d) ± five degrees directional heading. Each violation of timing and flight accuracy restrictions resulted in a score deduction (Appendix C).

THE TASK

The task required the subject to make two separate flights; one during the pre-test and the other during the post-test. Each flight time was approximately seven minutes in duration.

During the first minute the subject was to remain in a comfortable position in the cockpit prior to engaging in the actual flight performance. At the end of the first minute, the subject was given one minute to make a pre-flight check of all instrumentation necessary for takeoff. Takeoff was to commence on the three-minute mark on a heading of three hundred and sixty degrees. The subject was instructed to climb to an altitude of one thousand feet and to make as many thirty degree banks (alternating right and left turns from a heading of three

hundred and sixty degrees to three hundred and sixty degrees) as possible within a two-minute time period while maintaining an elevation of one thousand feet and an airspeed of one hundred knots. At the five-minute mark, the subject was instructed to roll out on his actual heading and descend at five hundred feet per minute while adjusting the rate of airspeed to land precisely at the seven minute mark.

TESTING PROCEDURES

Subjects were briefed on the nature of the experiment and were given an audio visual presentation which explained the project in general, outlining the nature of anxiety and its physiological effects on aviation pilot performance. Following the presentation, each subject was given a written description of the testing protocol along with Spielberger's Trait Anxiety Inventory which was to be completed at home and returned prior to pre-testing. Subjects were then given a specific time at which to arrive at the pre-testing site. Each subject was administered the Spielberger's State Anxiety Inventory immediately prior to flight testing. Each subject was then asked to position himself in the Frasca flight simulator and assume a comfortable position. EMG electrodes were then attached to two monitoring sites, the frontal region and the left forearm while EKG electrodes were attached to three prepared sites on the subject's chest.

The subject was then instructed to remain stationary for thirty seconds to allow surface electrode paste to penetrate after application and to allow transducer impedence to be checked. During this time, the subject was made aware of the task requirements and the evaluation procedure.

The flight instructor took his position at the instructor's

evaluation desk in order to monitor flight performance while physiological recordings were made from an uninhibiting area behind the flight simulator. Recording of the subject's heart rate were continuously recorded while muscle tension was manually recorded for all subjects at five-second intervals throughout the entire flight performance. Feedback for the target response consisted of a visual numerical display from the electromyograph voltmeter. The subject did not receive any evaluative scores following completion of the flight performance.

TREATMENT PROCEDURES

Once all subjects had been pre-tested they were rank ordered on state anxiety based on pre-test results. Subjects were then randomly blocked into three treatment groups based on high and low anxiety. The three treatment programmes are outlined below.

Group 1: EMG Biofeedback Training

Each subject in EMG feedback training received six, thirty-minute training sessions (Hiebert, 1979), which ran over a three-week period during which time all subjects abstained from flying. Biomechanical principles were discussed in order to understand the movements responsible for relaxation and contraction of the cranial, cervical and shoulder girdle musculature. All subjects received individual information about muscle tension levels via click feedback presented through headphones, as well as a visual meter indicating muscle tension in microvolts. In addition, all subjects were instructed to practise "duplicating the same feeling state associated with slow clicking" for fifteen to twenty minutes at home every day.

In the first EMG training session, subjects were seated in a

relaxed position while they were asked a number of questions pertaining to flying experience, physical condition and stress-related disorders (Appendix D). Surface electrodes were then placed on the frontal region and the subject was instructed to focus his attention on the micro-voltmeter as well as the audio intensity and to explore a variety of strategies that might be successful in slowing the clicking rate and decrease neuromuscular innervation. The subject was provided with a number of cues which assisted him in concentrating on scanning the body for different feelings or sensations that may be associated with a reduced visual and audio feedback. Three, ninety-second probes of EMG activity were taken at the eight-minute, fifteen-minute, and twenty-minute points in each training session (Hiebert, 1979).

In session two, the stages in the biofeedback training process (Basmajian, 1979) were explained and a discussion about the nature of passive control was developed. In the second training session, subjects were instructed to become more selective in their exploration, with a goal in mind of developing a strategy that would reliably produce and maintain a slower rate of neuromuscular innervation.

In the third session, EMG electrodes were placed on both the frontal region and on the left forearm. The subject was again instructed to focus his attention on the microvoltmeter as well as the audio intensity and to explore a variety of strategies that might be successful in slowing the clicking rate and decreasing neuromuscular innervation. Input weighting of electromyographical feedback initially was calibrated to monitor contraction and relaxation of the forearm only and then later centred to monitor equally from both monitoring sites to allow the subject to distinguish between specific areas of muscle tension (Basmajian, 1979).

In the last three sessions, emphasis was placed on identifying the personal idiosyncratic feeling indicators that could serve as internal feedback identifying a relaxed state. Also, the idea of a stimulus cue was introduced to elicit relaxation. During the final session a weaning period occurred where subjects were asked to produce relaxation responses without visual or auditory feedback in order to check out their perception of being relaxed.

Plates 10, 11 and 12 illustrate an EMG biofeedback training session and Appendix E contains an EMG training chart sample.

Group 2: Autogenic Relaxation Training

Treatment procedures replicated the exact protocol as that of the biofeedback group except an autogenic relaxation tape replaced EMG biofeedback. Subjects cued to the autogenic phases of bodily warmth and heaviness on the tape and recruited similar internal strategies to diminish muscular tension. Plate 13 illustrates an autogenic training session.

Training times, duration and anatomical position and baseline probes of EMG activity remained constant throughout both treatments.

Group 3: Control

No treatment was given to this group. However, each control subject was instructed to appear at the treatment centre on six separate occasions where they were asked "to take a comfortable seated position" where EMG electrodes were attached and baseline probes of EMG activity were taken throughout a twenty-minute period at precisely the same interval as that of the experimental group training sessions at the eight,

Plate 10. EMG biofeedback training session (frontal aspect).

Plate 11. EMG biofeedback training session (posterior aspect).

Plate 12. EMG biofeedback training session (lateral aspect).

Plate 13. Auto suggestion training session.

fifteen and twenty-minute marks. Progress reports were kept on each subject during the treatment programme and a feedback form (Appendix F) was completed following the treatment programme.

DATA ANALYSIS

The data collected for each subject included fourteen heart rate scores which were continuously recorded and averaged every thirty seconds over a seven-minute flight sequence and fourteen electromyographical scores which were recorded using a partial interval time sampling technique (Bijou, 1968) every five seconds and averaged every thirty seconds over a seven-minute flight sequence. These scores, along with trait and state anxiety scores and performance scores for each subject, were taken both in the pre-test and post-test. All dependent variables were descriptively analyzed by means of graphs.

Three-factor analyses of variance with repeated measures were performed on trait and state anxiety scores, EMG scores, EKG scores, and performance scores between the three treatment groups. The $p < .01$ was accepted as the criterion level for significance in this study.

Simple effects tests were then performed to identify significant mean differences in A-State, EMG and EKG test scores for three treatment groups.

LIMITATIONS

Findings of the present study may have been limited by the following factors:

1. The reliability and accuracy of the measurement and recording equipment.

2. The possible discomfort experienced by surface electrode connections during flight testing.

DELIMITATIONS

Findings of the present study were delimited by the following factors:

(1) The sampling of subjects was limited to twenty-four male aviation pilots between the ages of eighteen and twenty-four years, enrolled in the second year of a two-year aviation programme at Selkirk College, Castlegar, British Columbia.

(2) The recording of heart rate was limited to the electrocardiogram, while muscle tension was limited to readings from the frontalis and left flexor carpi ulnaris muscles.

(3) The biofeedback training was limited to electromyographical feedback from an Autogen 1700 EMG biofeedback unit.

(4) Anxiety scores were limited to Spielberger's Trait-State Anxiety Inventroy.

(5) Autogenic relaxation was limited to the use of an autosuggestion relaxation cassette tape (Budzynski, 1977).

(6) The flight performance testing was limited to the use of a Frasca 101-G flight simulator and performance tracking system.

Chapter 4

RESULTS AND DISCUSSION

Three-factor analyses of variance with repeated measures on one factor were performed in an attempt to identify the effects of two types of anxiety reduction therapy on anxiety level and flight performance. Six dependent variables were analyzed. The analyses of variance will be discussed sequentially in conjunction with the graphs of mean group responses for Spielberger's Trait and State Anxiety Inventories, physiological responses and performance, after which some analyses of related concerns will be presented. The letters A, B, and C on the graph legends denote: A (Autogenic Group); B (Biofeedback Group); C (Control Group). Raw score values are contained in Appendix G.

RESULTS

Spielberger's Trait and State Anxiety Inventories

The analysis of variance for the A-Trait score showed only the main effect for anxiety level to be significant, $F(1,18) = 27.69$, $p < .01$. The analysis of variance summary is found in Table 1. The group means on the A-Trait variable are displayed in Table 2, while the relationship of mean trait scores for the treatment groups are depicted in Figures 1, 2, and 3.

Analysis of the A-State component found the difference between the high and low anxiety level to be highly significant, $F(1,18) =$

Table 1

Summary of Analysis of Variance on A-Trait Scores

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	p
Between Subjects	2206.82	23			
A (Group)	107.38	2	53.69	1.17	0.33
B (Anxiety Level)	1271.02	1	1271.02	27.69	0.01
AB	2.04	2	1.02	0.02	0.98
Subjects Within Groups	826.38	18	45.91		
Within Subjects	52.52	24			
C (Time)	1.69	1	1.69	0.90	0.36
AC	11.38	2	5.68	3.02	0.07
BC	4.69	1	4.68	2.49	0.13
ABC	0.88	2	0.44	0.23	0.80
C x Subjects Within Groups	33.88	18	1.88		

Table 2

Mean A-Trait Test Scores for Three Treatment Groups

Treatment Group	Anxiety Level	Scores Pre-test	Scores Post-test
Autogenic	High	45.00	45.00
	Low	34.00	34.00
	Combined	39.50	39.50
Biofeedback	High	42.25	29.75
	Low	31.75	30.75
	Combined	37.00	35.25
Control	High	44.25	43.75
	Low	33.00	34.25
	Combined	38.63	39.00

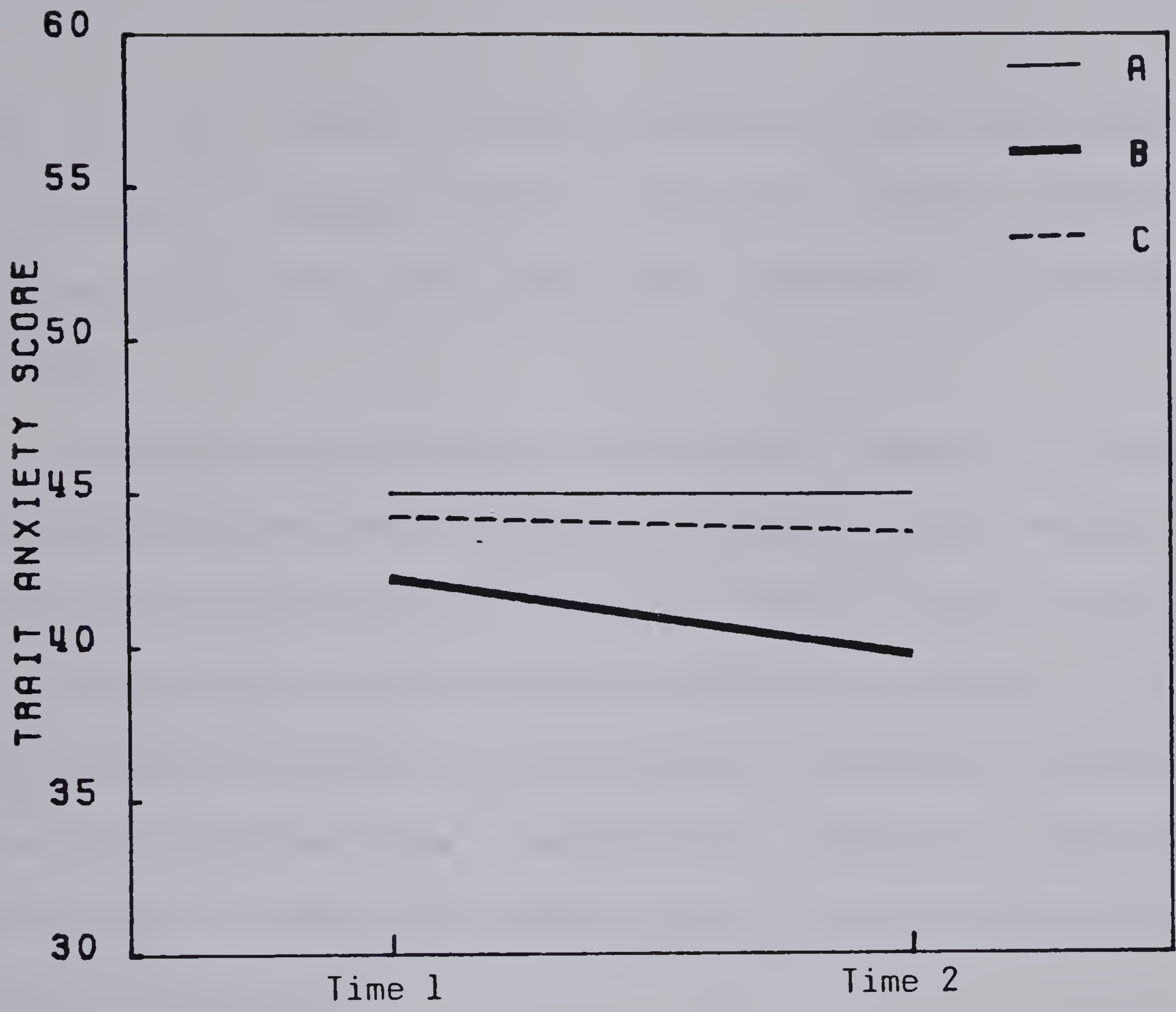

Figure 1. Mean trait scores for three treatment groups, at pre-treatment and post-treatment testing.

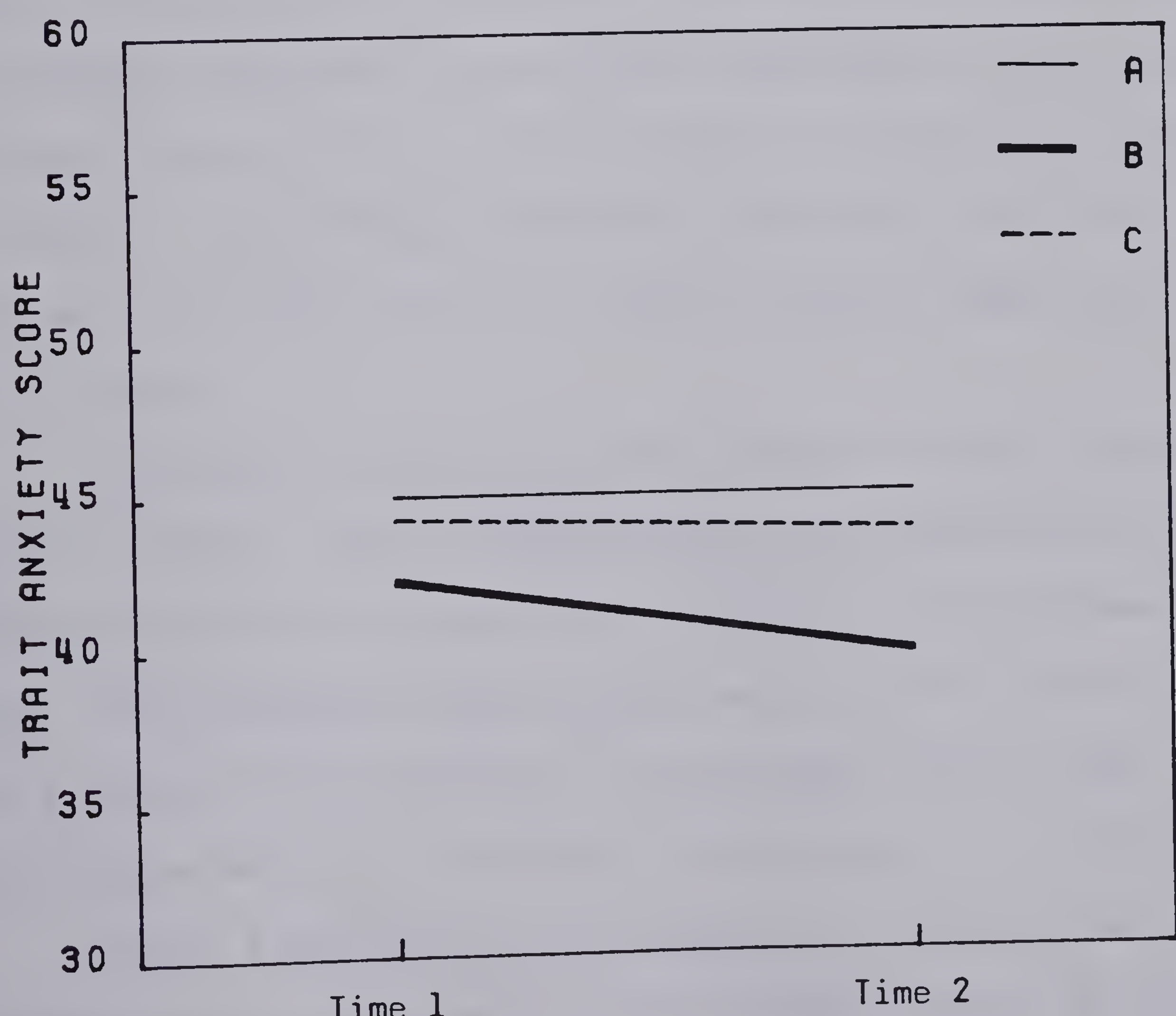

Figure 2. Mean trait scores for high anxious treatment groups, at pre-treatment and post-treatment testing.

69.92, $p < .01$. Further, in this analysis both the time factor, labelled C in analysis of variance summary (Table 3), $F(1,18) = 23.29$, $p < .01$, and the group x time interaction were also significant, $F(2,18) = 8.55$, $p < .01$.

For both main effects a significant F resulted. The decrease in the state scores can be shown by comparing the pre- and post-test means of the high anxious subjects with those of the low anxious subjects. For the high anxious subjects the pre-test mean score of 57.42 dropped to 53.25, while for the low anxious subjects the pre- and post-test mean scores were 37.08 and 34.42, respectively. Similarly, the average pre-state score for both groups combined was 47.25 while the average post-state score was 45.31.

In order to identify the reason for the significant interaction simple effects tests were performed. They showed the groups to be not significantly different at the pre-test measurement but significantly different from each other in the post-test. The means are displayed in Table 4. The difference between the post-test group means for B versus C, B versus A and for A versus C were all significant beyond the .01 level.

In Figure 4, mean state anxiety scores for three treatment groups are shown. The autosuggestive group pre-test score was 47.25 while the post-test score was 43.38, producing a 3.87 decrement between tests. The biofeedback group pre-test score was 47.25 and the post-test score was 40.50 producing a 6.75 decrement between tests. The control group mean score was 47.63 in both the pre- and post-tests.

Figure 5 displays mean state scores for high anxious subjects. The autosuggestive group shows a 5.25 decrement between the pre-test and

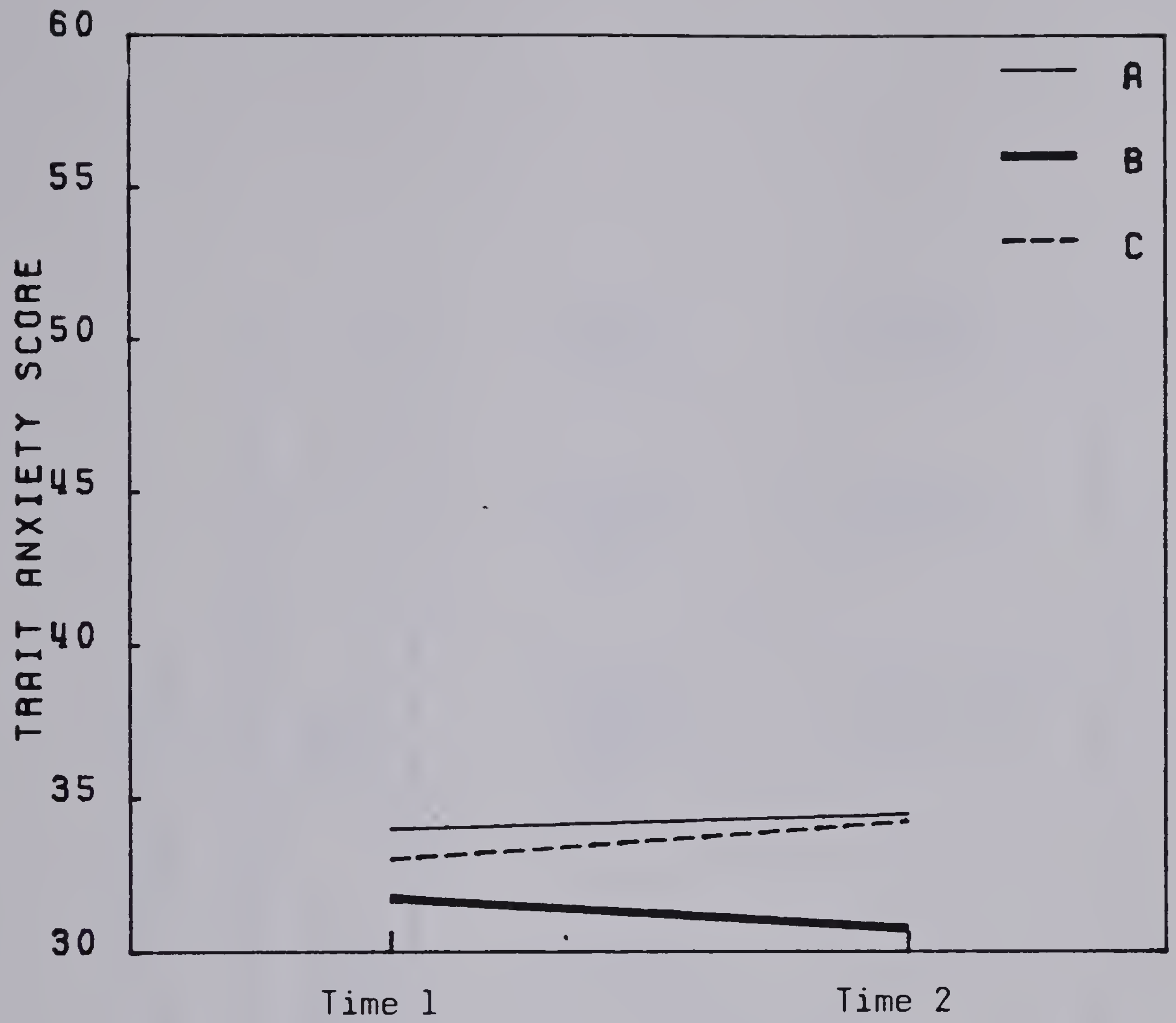

Figure 3. Mean trait scores for low anxious treatment groups, at pre-treatment and post-treatment testing.

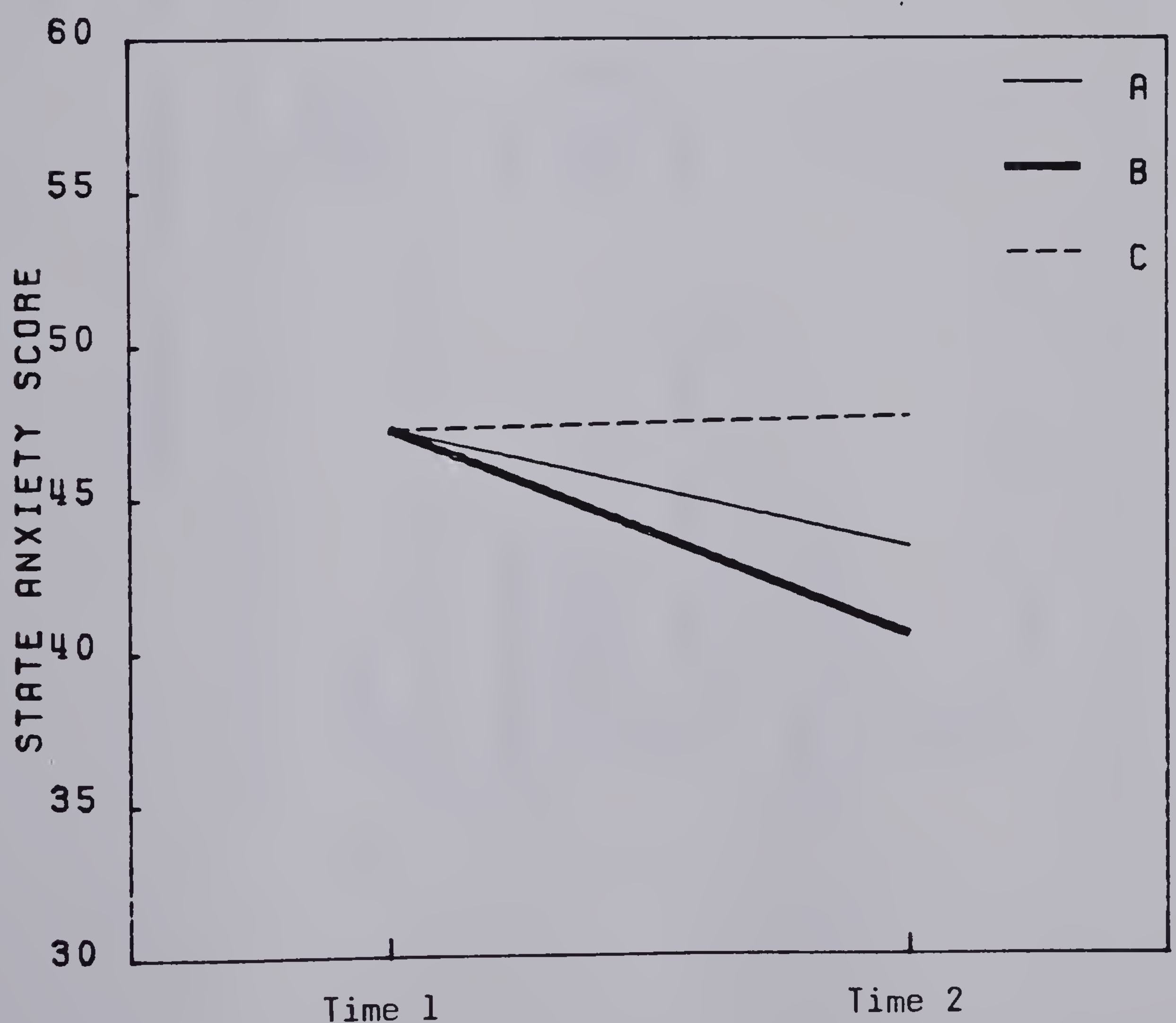

Figure 4. Mean state scores for three treatment groups, at pre-treatment and post-treatment testing.

Table 3

Summary of Analysis of Variance on A-State Scores

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	p
Between Subjects	5890.91	23			
A (Group)	102.79	2	51.40	0.78	0.47
B (Anxiety Level)	4602.08	1	4602.08	69.92	0.01
AB	1.29	2	0.65	0.01	0.99
Subjects Within Groups	1184.75	18	65.82		
Within Subjects	361.00	24			
C (Time)	140.08	1	140.08	23.29	0.01
AC	102.79	2	51.40	8.55	0.01
BC	6.75	1	6.75	1.12	0.30
ABC	3.13	2	1.56	0.26	0.77
C x Subjects Within Groups	108.25	18	6.01		

Table 4

Mean A-State Test Scores for Three Treatment Groups

Treatment Group	Anxiety Level	Scores Pre-test	Scores Post-test
Autogenic	High	57.50	52.25
	Low	37.00	34.50
	Combined	47.25	43.38
Biofeedback	High	57.50	50.00
	Low	37.00	31.00
	Combined	47.25	40.50
Control	High	57.25	57.50
	Low	37.25	37.75
	Combined	47.63	47.63

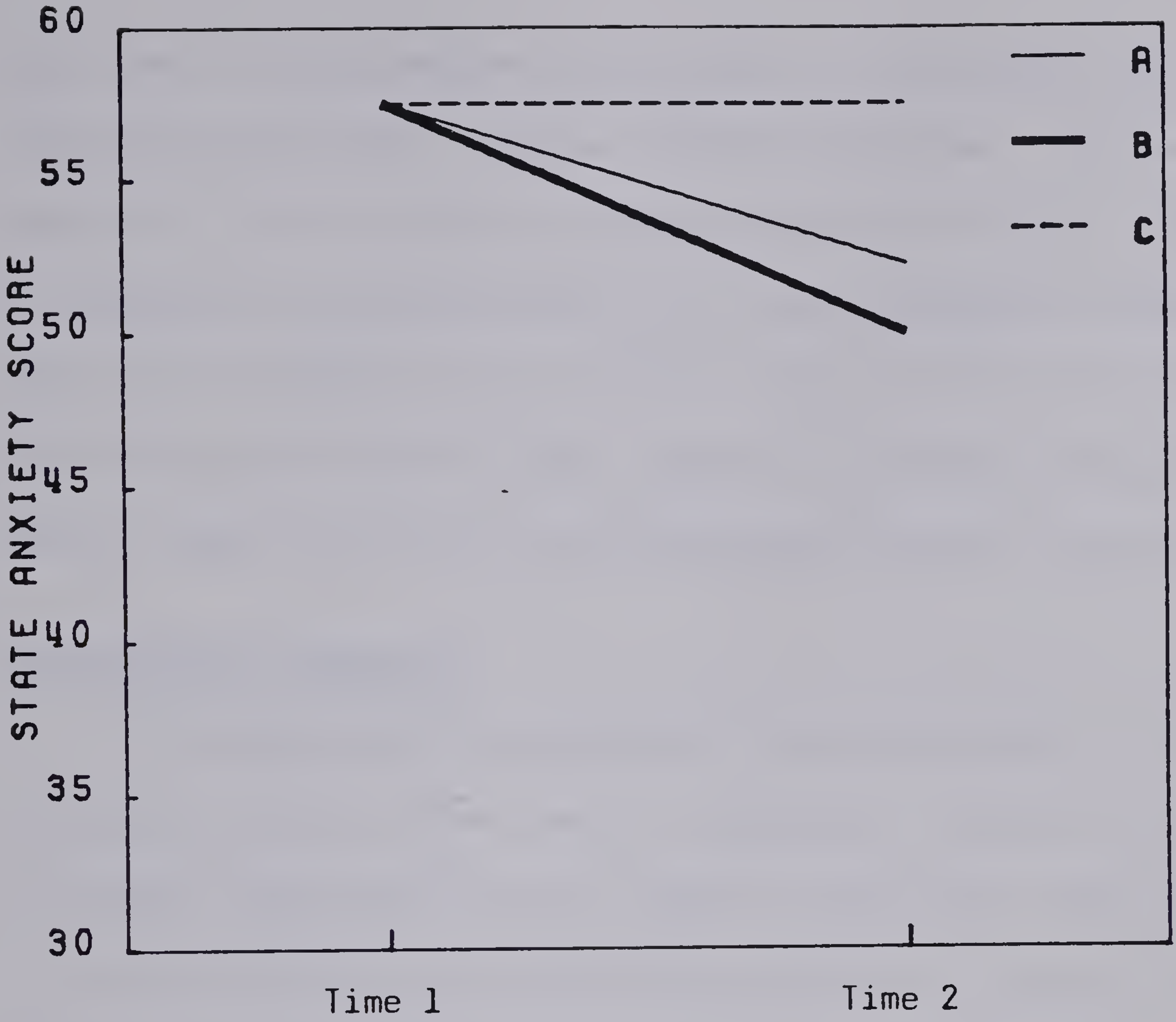

Figure 5. Mean state scores for high anxious treatment groups, at pre-treatment and post-treatment testing.

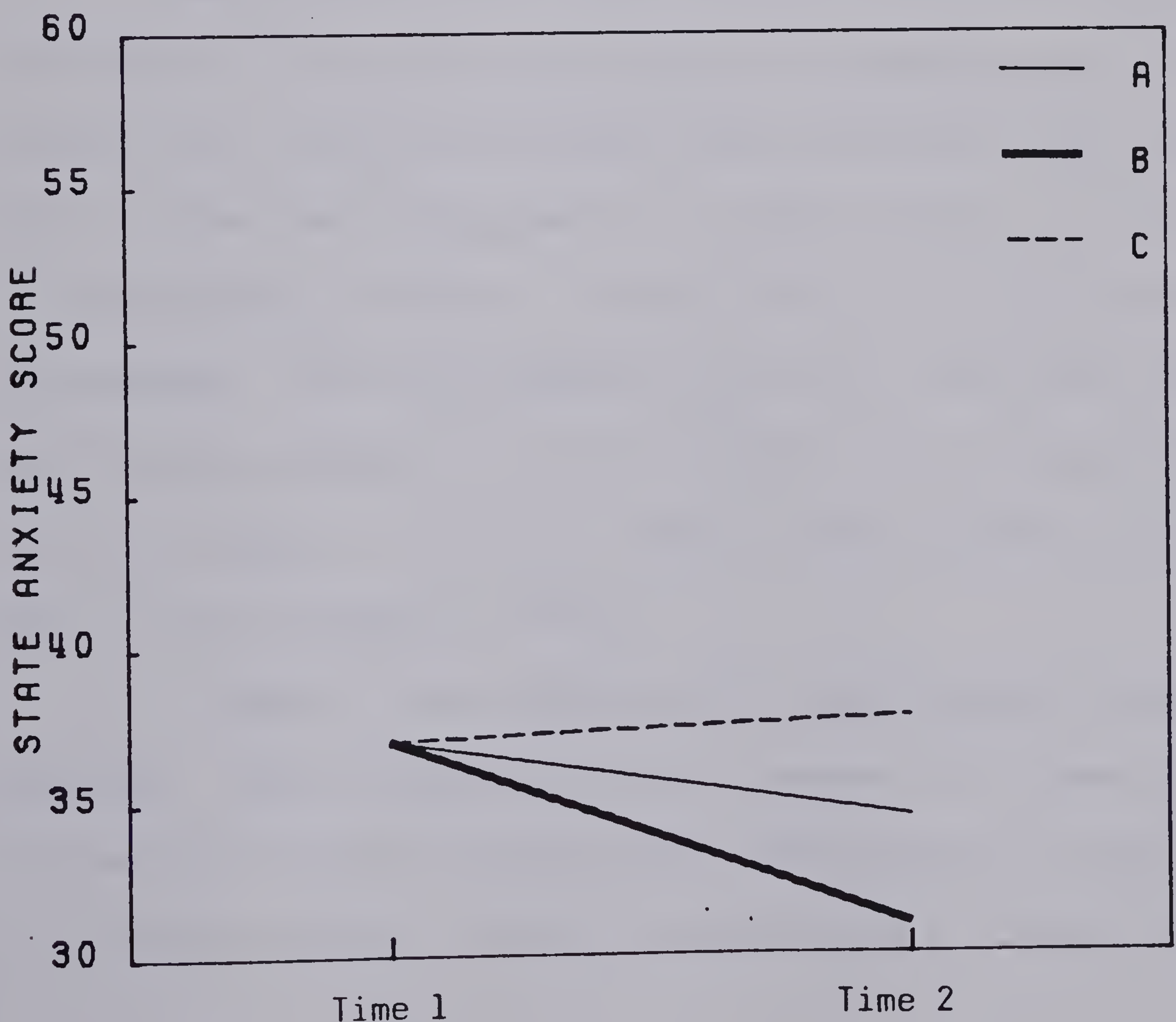

Figure 6. Mean state scores for low anxious treatment groups, at pre-treatment and post-treatment testing.

post-test, the biofeedback group shows a 7.5 decrement over time, while scores for the control remains virtually the same. The mean state scores for the low anxious treatment groups are shown in Figure 6. The autosuggestive group produced a 2.50 anxiety decrement between tests while the biofeedback group produced a mean score of 37.0 in the pre-test and 31.0 in the post-test, giving a 6.0 anxiety decrement between tests. Again, the control group remained virtually the same.

Physiological Responses

The analysis of variance for EMG scores showed no main effect for group or anxiety level and no interaction. However, the analysis of variance depicted in Table 5 shows a significant times effect, $F\ (1,18) = 51.76$, $p < .01$; and also a significant group x time interaction, $F\ (2,18) = 29.97$, $p < .01$.

Simple effects tests were performed to identify significant mean differences in EMG test scores for three treatment groups. The mean pre-test score for the biofeedback group was significantly greater than that of either the autosuggestion or control groups, $p < .01$, which were not significantly different from each other. At the post-test the order was reversed. The autosuggestion and control groups were still not significantly different but the biofeedback group was significantly less than both groups, $p < .01$. The means for these groups are displayed in Table 6 and in Figures 7, 8 and 9.

In Figure 7, mean EMG scores for three treatment groups are displayed. The autosuggestive group produced a 5.06 mean score in the pre-test and a 4.82 in the post-test, producing only a slight decrement of .24 between tests. The mean pre-test score of the biofeedback group

Table 5

Summary of Analysis of Variance on EMG Scores

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	p
Between Subjects	90.96	23			
A (Group)	0.28	2	0.14	0.03	0.97
B (Anxiety Level)	13.27	1	13.27	3.24	0.09
AB	3.69	2	1.85	0.45	0.64
Subjects Within Groups	73.72	18	4.10		
Within Subjects	19.73	24			
C (Time)	7.30	1	7.30	51.76	0.01
AC	8.46	2	4.23	29.97	0.01
BC	0.49	1	0.49	3.47	0.08
ABC	0.94	2	0.47	3.32	0.06
C x Subjects Within Groups	2.54	18	0.14		

Table 6

Mean EMG Test Scores for Three Treatment Groups

Treatment Group	Anxiety Level	Scores Pre-test	Scores Post-test
Autogenic	High	5.24	4.92
	Low	4.88	4.73
	Combined	5.06	4.83
Biofeedback	High	6.81	4.25
	Low	4.68	3.30
	Combined	5.74	3.78
Control	High	5.52	5.44
	Low	4.25	4.04
	Combined	4.88	4.74

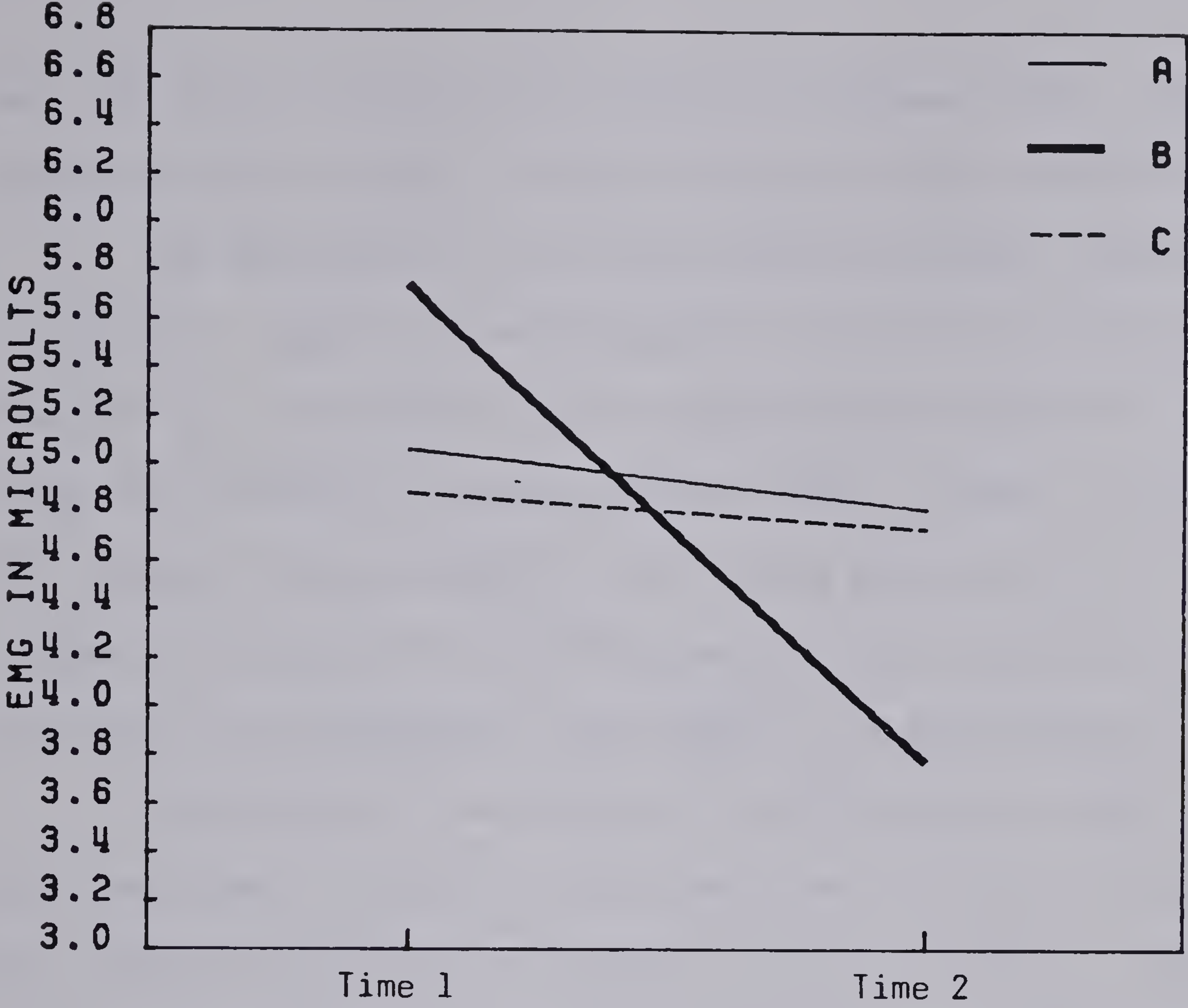

Figure 7. Mean EMG for three treatment groups, at pre-treatment and post-treatment testing.

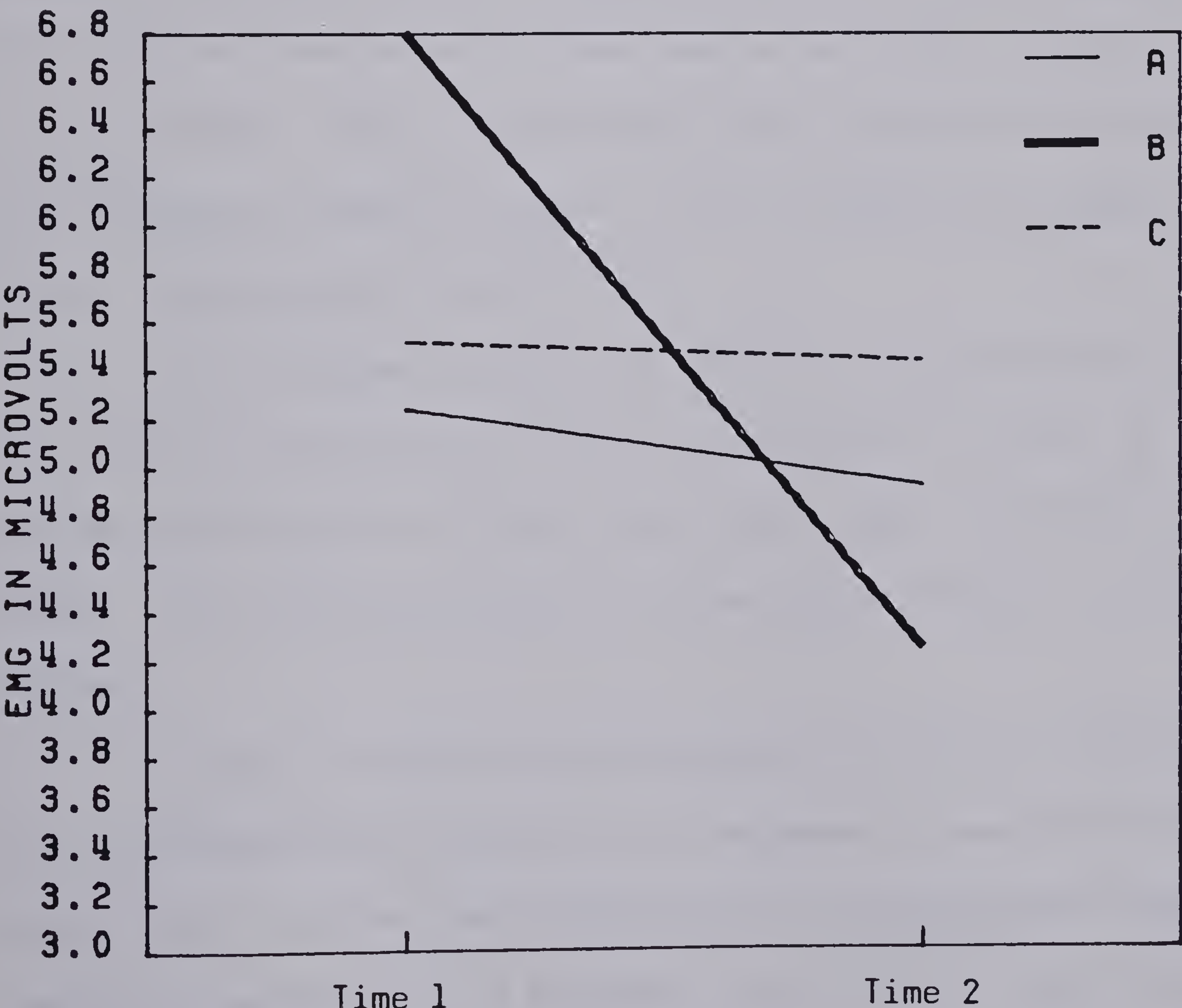

Figure 8. Mean EMG for high anxious treatment groups, at pre-treatment and post-treatment testing.

was 3.78 with a 1.96 mean score decrement between tests. The control group remained virtually the same between pre- and post-tests.

The mean scores of the high anxious treatment groups are shown in Figure 8. Again, the autosuggestive and control groups show a slight decrease over time while the biofeedback group produces 2.56 mean score decrement between the pre-test and post-test. Figure 9 depicts mean EMG treatment group scores for low anxious groups where both the autosuggestive group and the control show only very slight decreases over time while the biofeedback group shows a 1.38 mean EMG score decrement.

The analysis of variance on the EKG variable showed a significant heart rate x anxiety level interaction, $F\ (1,18) = 4.90$, $p < .05$. The summary of analysis of variance appears in Table 7. Simple effects tests were performed to identify significant mean differences in EKG test scores for the two levels of anxiety within the three treatment groups. Both high and low anxiety groups were significantly different on the pre- and post-tests. The mean heart rate test scores for the three treatment groups are found in Table 8, while Figures 10, 11 and 12 graphically depict the group means across time.

The difference between the mean of the high and low anxiety groups was 11.87 on the pre-test, which was significant at the .01 level, while on the post-test the difference was 6.28, still significant at the .01 level. The difference between the two groups dropped by 5.59 beats per minute.

Figure 10 depicts mean EKG scores for three treatment groups. The biofeedback group shows a 6.31 decrease in mean heart rate scores between the pre- and post-tests while the autosuggestive group and the control group show a 1.47 decrement and a 1.51 increase, respectively,

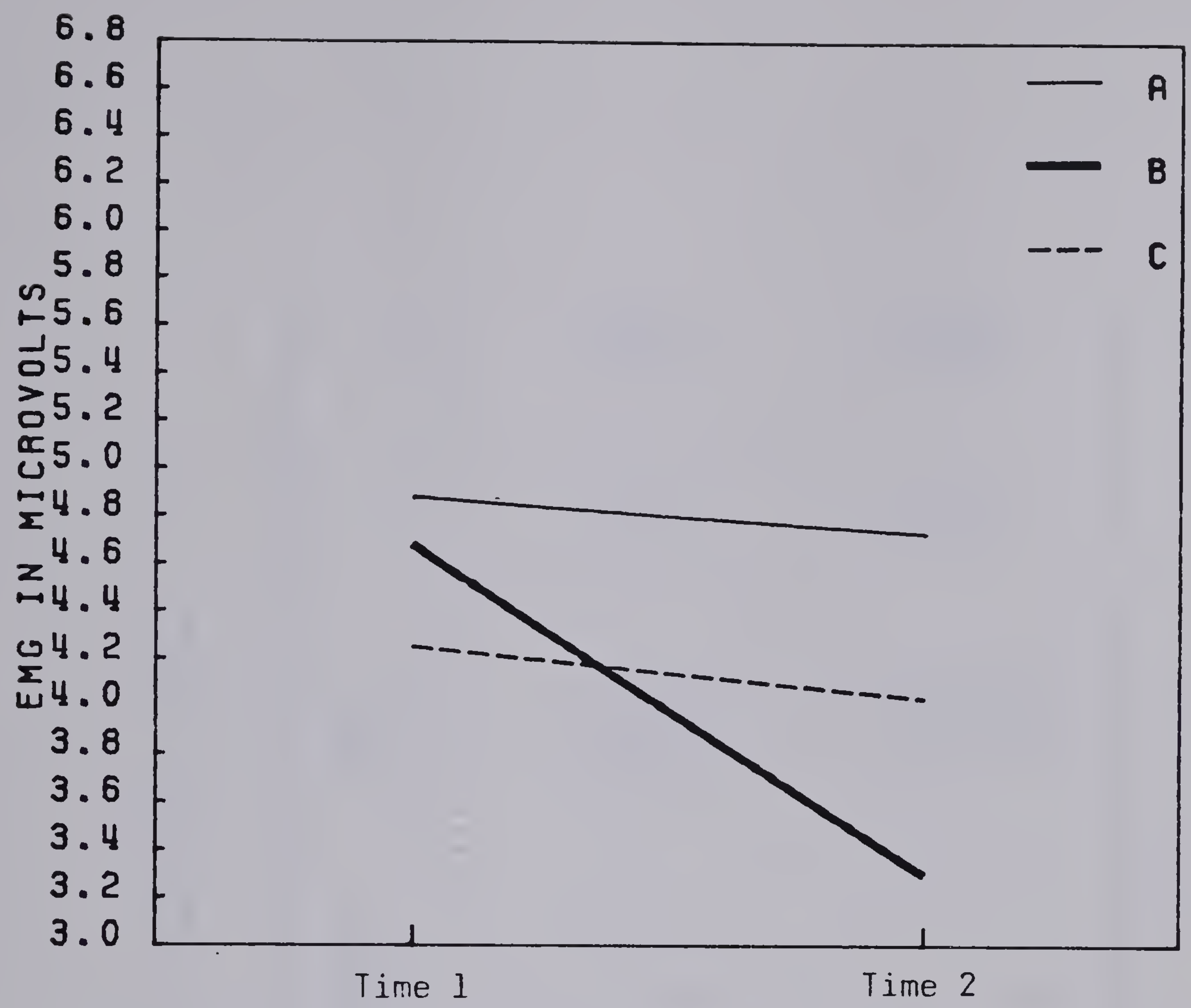

Figure 9. Mean EMG for low anxious treatment groups, at pre-treatment and post-treatment testing.

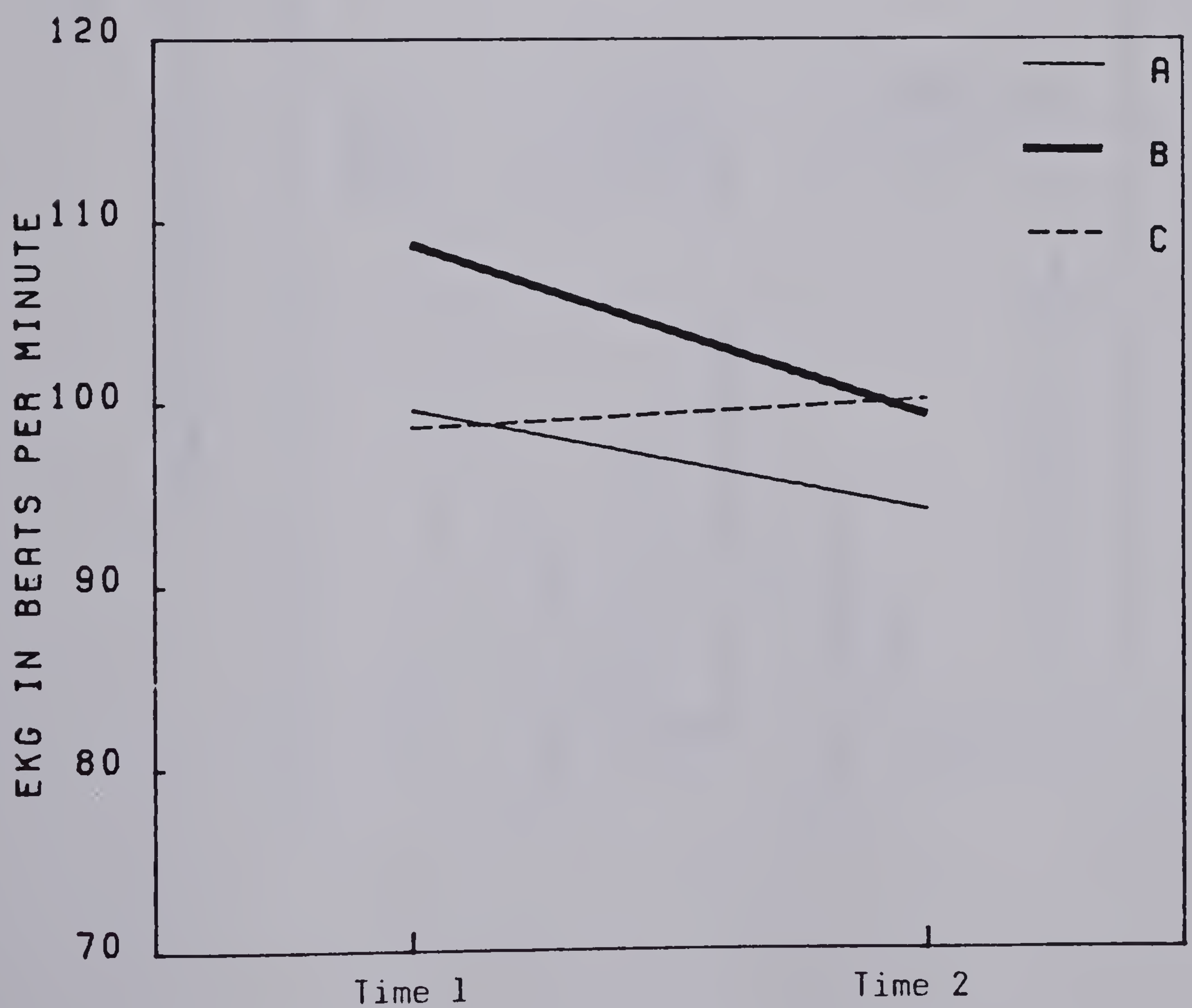

Figure 10. Mean EKG for three treatment groups, at pre-treatment and post-treatment testing.

Table 7

Summary of Analysis of Variance on Heart Rate Scores

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	p
Between Subjects	12265.02	23			
A (Group)	287.29	2	143.65	0.25	0.78
B (Anxiety Level)	988.79	1	988.79	1.71	0.21
AB	556.63	2	278.31	0.48	0.62
Subjects Within Groups	10432.31	18	579.58		
Within Subjects	631.06	24			
C (Time)	52.68	1	52.68	2.76	0.11
AC	124.60	2	62.30	3.26	0.06
BC	93.52	1	93.52	4.90	0.04
ABC	16.59	2	8.29	0.43	0.65
C x Subjects Within Groups	343.66	18	19.09		

Table 8

Mean Heart Rate Test Scores for Three Treatment Groups

Treatment Group	Anxiety Level	Scores Pre-test	Scores Post-test
Autogenic	High	99.63	94.09
	Low	89.52	92.09
	Combined	94.57	93.10
Biofeedback	High	108.57	99.34
	Low	87.14	83.93
	Combined	97.95	91.64
Control	High	100.63	100.91
	Low	96.73	99.46
	Combined	98.68	100.19

in mean heart rate score as a function of time.

In Figure 11, the high anxious autosuggestive group produced a mean pre-test heart rate score of 99.63 and post-test score of 94.09 showing a 5.54 EKG decrement between tests. The high anxious biofeedback group reduced their mean heart rate scores by 9.23 beats per minute between pre- and post-tests while the control group remained the same.

Figure 12 illustrates the mean EKG scores for the low anxious treatment groups. The autosuggestive and control groups show a 2.57 and a 2.73 average increase in heart rate over time while the biofeedback group decreased 3.21 beats per minute from the pre- to post-tests. Graphed profiles of mean group physiological responses throughout the flight sequence over time are found in Appendix I.

Performance

The last pair of analyses examined flight performance scores. The analyses of variance for the flight and time performance scores showed no significant differences. The analysis of variance summary on the two performance factors are found in Tables 9 and 11. The group means on the flight and time performance factors are displayed in Tables 10 and 12, while the relationship of mean flight and time performance scores for the treatment groups are depicted in Figures 13, 14 and 15.

Analysis of Treatment Group Training Data

It was postulated that EMG biofeedback and autosuggestive training would effectively facilitate learning to self-regulate muscle tension and promote relaxation. To test this hypothesis, three-way analyses

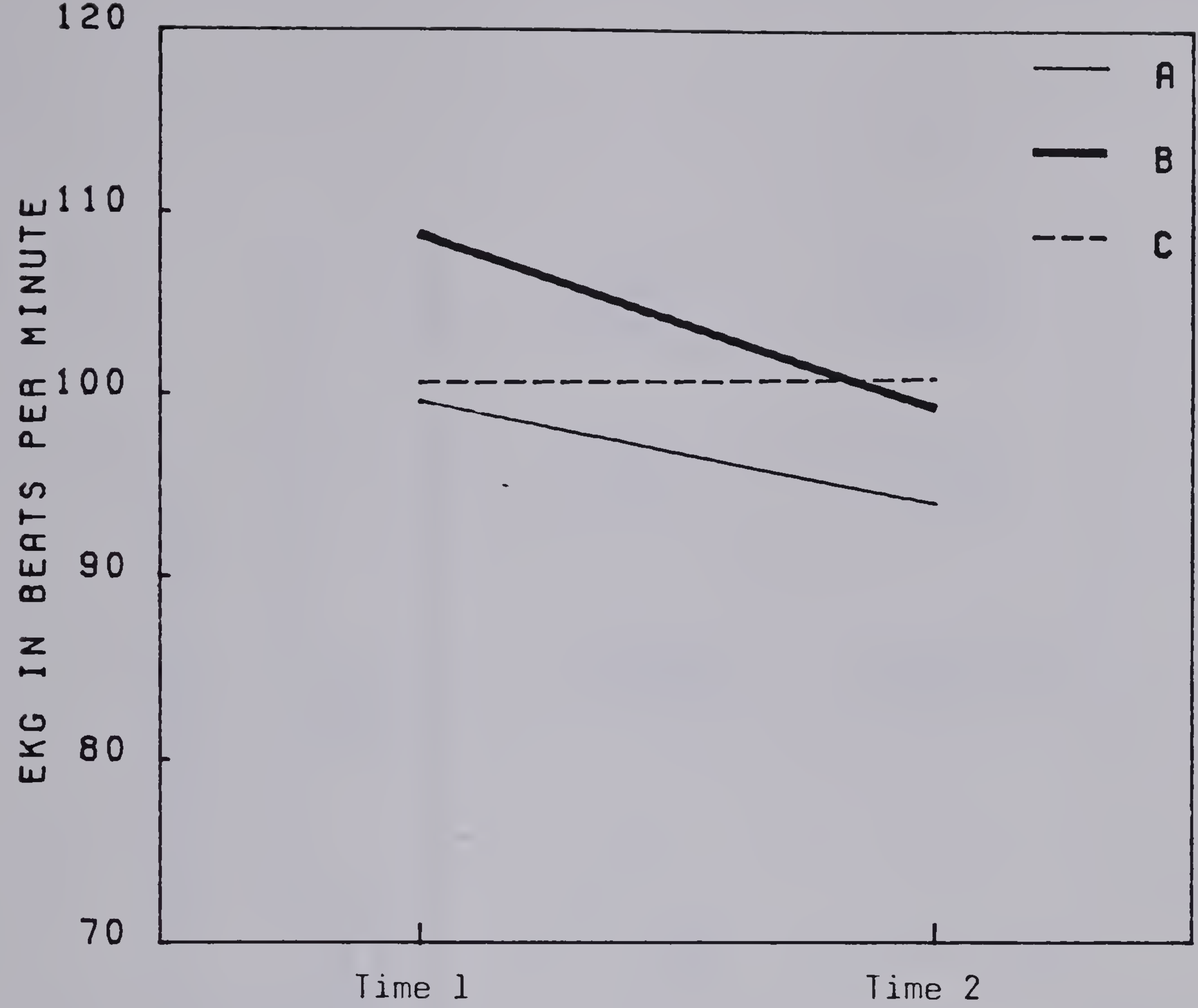

Figure 11. Mean EKG for high anxious treatment groups, at pre-treatment and post-treatment testing.

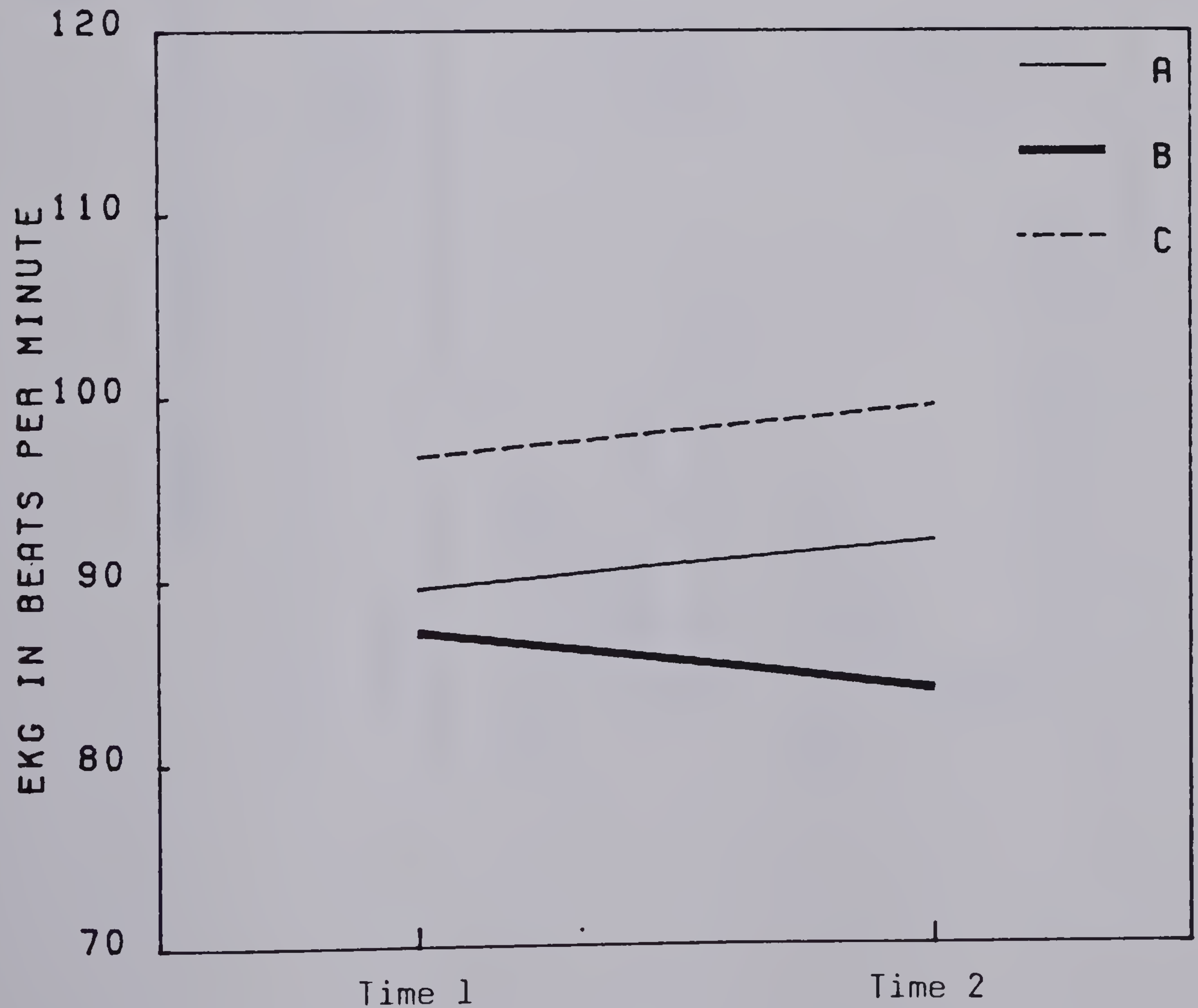

Figure 12. Mean EKG for low anxious treatment groups, at pre-treatment and post-treatment testing.

Table 9

Summary of Analysis of Variance on Flight Performance Scores

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	p
Between Subjects	13.13	23			
A (Group)	1.39	2	0.69	1.24	0.31
B (Anxiety Level)	1.51	1	1.51	2.68	0.12
AB	0.14	2	0.07	0.12	0.89
Subjects Within Groups	10.09	18	0.56		
Within Subjects	4.64	24			
C (Time)	0.26	1	0.26	1.16	0.30
AC	0.14	2	0.07	0.31	0.74
BC	0.13	1	0.13	0.59	0.45
ABC	0.14	2	0.07	0.31	0.74
C x Subjects Within Groups	3.97	18	0.22		

Table 10

Mean Flight Performance Test Scores for Three Treatment Groups

Treatment Group	Anxiety Level	Scores Pre-test	Post-test
Autogenic	High	6.25	6.75
	Low	6.75	6.75
	Combined	6.50	6.75
Biofeedback	High	6.63	6.88
	Low	7.00	7.12
	Combined	6.81	7.00
Control	High	6.25	6.25
	Low	6.75	6.75
	Combined	6.50	6.50

Table 11

Summary of Analysis of Variance on Time Performance Scores

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	p
Between Subjects	32.00	23			
A (Group)	0.50	2	0.25	0.17	0.84
B (Anxiety Level)	5.33	1	5.33	3.69	0.07
AB	0.17	2	0.08	0.06	0.94
Subjects Within Groups	26.00	18	1.44		
Within Subjects	6.00	24			
C (Time)	0.33	1	0.33	1.20	0.29
AC	0.67	2	0.33	1.20	0.32
BC	0.00	1	0.00	0.00	1.00
ABC	0.00	2	0.00	0.00	1.00
C x Subjects Within Groups	5.00	18	0.28		

Table 12

Mean Time Performance Test Scores for Three Treatment Groups

Treatment Group	Anxiety Level	Scores Pre-test	Post-test
Autogenic	High	6.25	6.25
	Low	6.75	6.75
	Combined	6.50	6.50
Biofeedback	High	6.00	6.50
	Low	6.75	7.25
	Combined	6.38	6.88
Control	High	6.00	6.00
	Low	6.75	6.75
	Combined	6.38	6.38

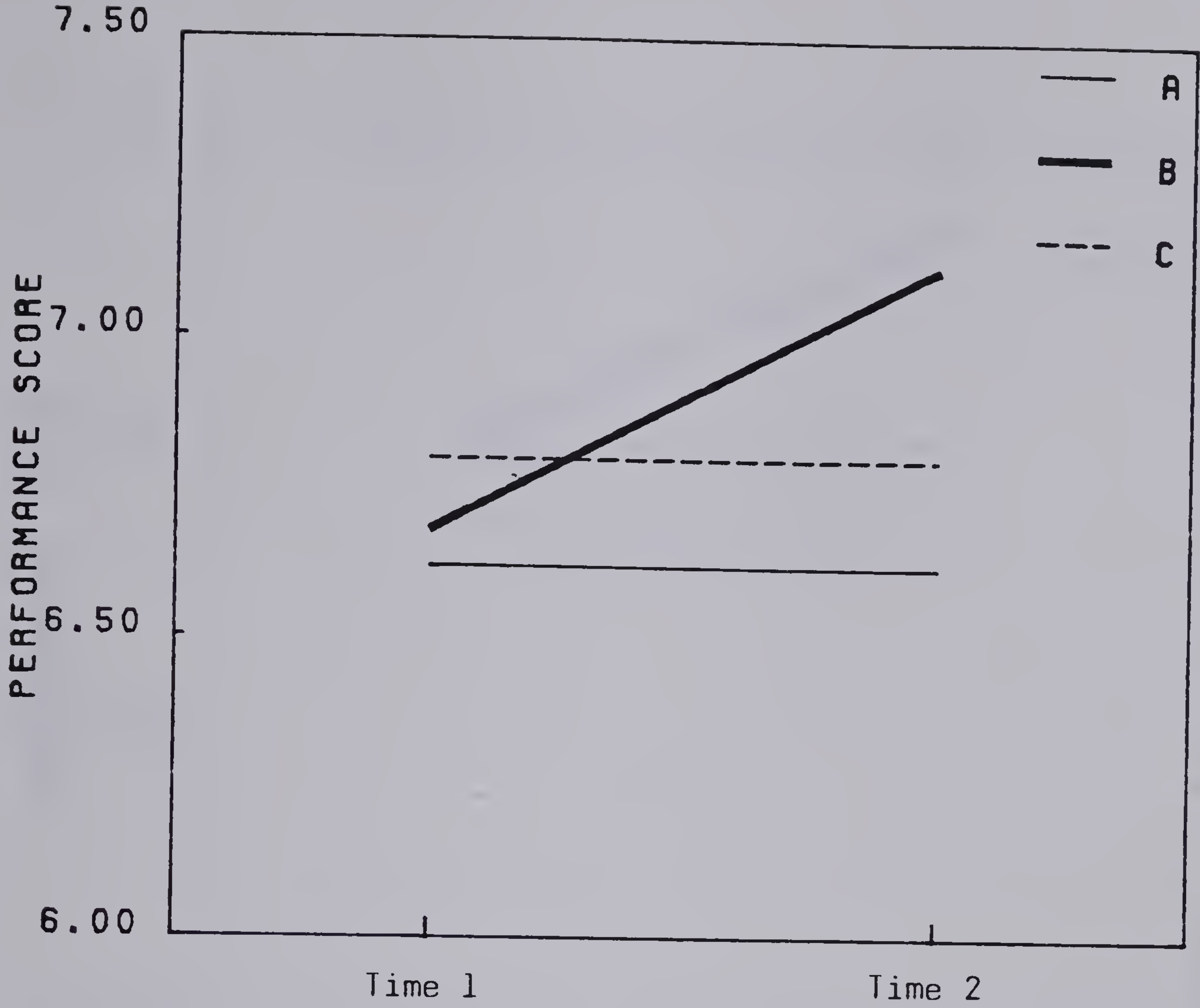

Figure 13. Mean performance scores for three treatment groups, at pre-treatment and post-treatment testing.

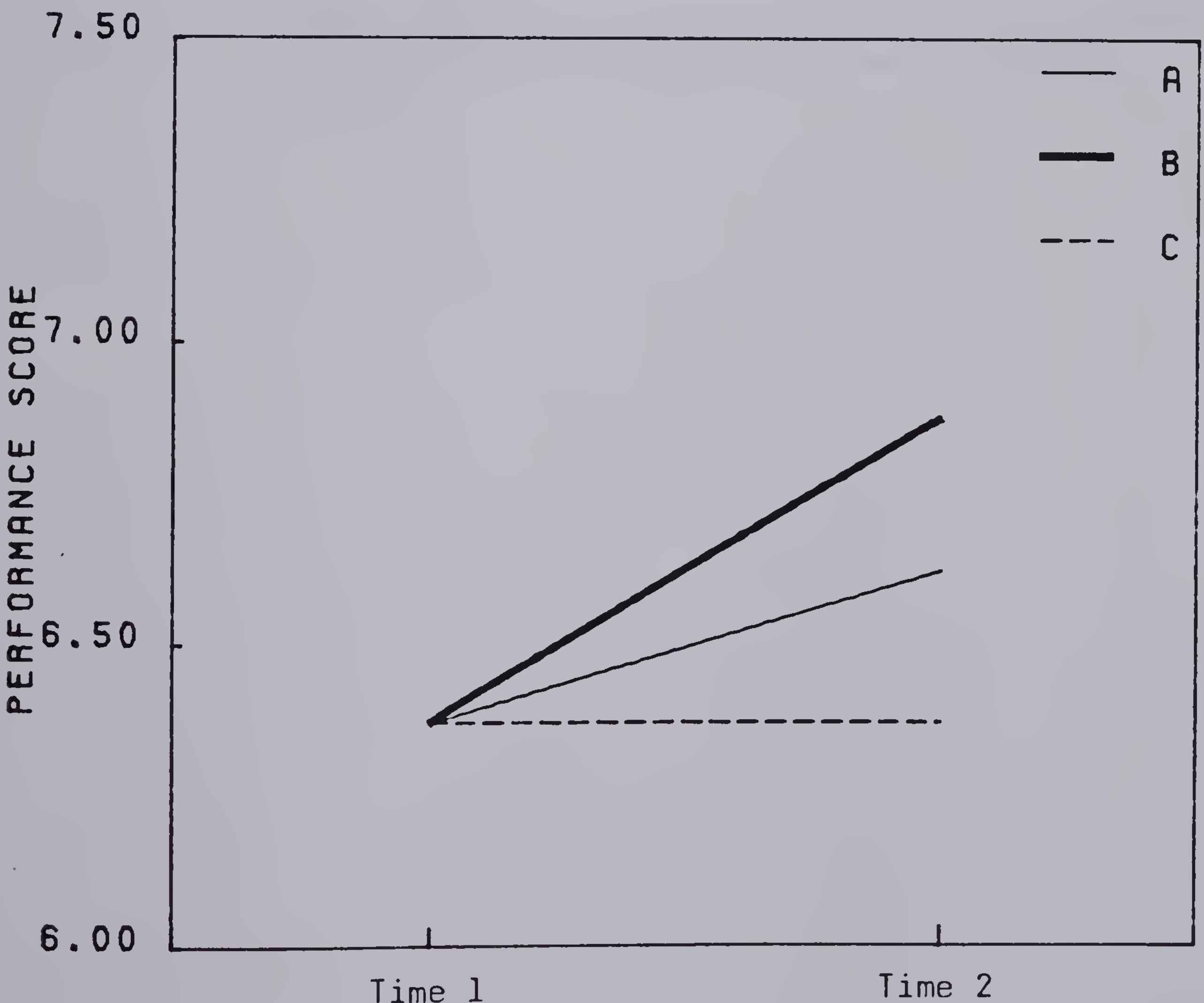

Figure 14. Mean performance scores for high anxious treatment groups, at pre-treatment and post-treatment testing.

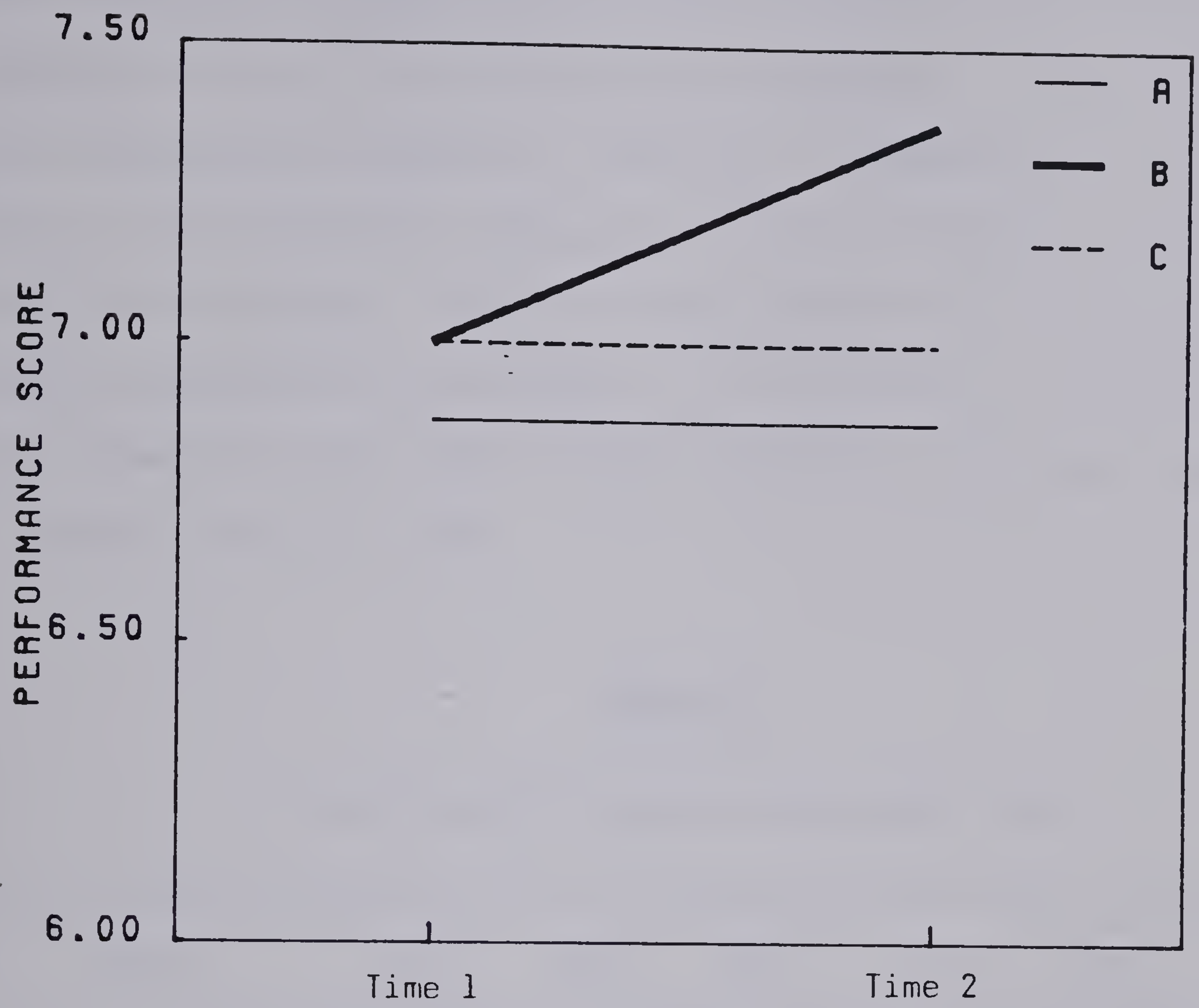

Figure 15. Mean performance scores for low anxious treatment groups, at pre-treatment and post-treatment testing.

of variance with repeated measures were conducted, three different EMG probes were taken in each group training session. The mean EMG levels for each group are presented in Table 13. The summaries of analyses of variance are presented in Appendix H. The EMG biofeedback treatment group, the autogenic treatment group and the control group all showed a significant times effect, $p < .01$. However, the EMG biofeedback treatment group showed a greater decrease in EMG across time, $F\ (5,35) = 79.84$, $p < .01$.

Table 13

Mean Group EMG Training Scores Over Time

Group	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Autogenic	2.55	2.46	2.42	2.24	2.03	2.01
Biofeedback	2.51	2.34	1.93	1.44	1.31	1.26
Control	2.87	2.85	2.80	2.73	2.65	2.64

DISCUSSION

In this study, the effectiveness of EMG biofeedback and auto-suggestive training on change in anxiety level and performance was examined for twenty-four aviation pilots. Anxiety change was determined by pre- and post-test comparison of Spielberger's State and Trait Anxiety scores, heart rate scores and EMG scores while the quality of performance was assessed on two factors, timing and flight accuracy over time. The

main hypotheses proposed in this research were concerned with anxiety change and performance between two test periods. In this section, each research hypothesis will be discussed in conjunction with the data analyses.

The first three research hypotheses proposed that therapeutic intervention would prove successful in reducing performance anxiety and the degree of success would be a function of the type of treatment administered. Data from the analyses of variance of A-State anxiety and EMG showed this effect. The reduction in anxiety that subjects in biofeedback and autosuggestion treatment groups experienced support the first and third hypotheses.

Further examination of the data indicates that pilots receiving EMG biofeedback experienced a greater anxiety reduction than pilots receiving autosuggestion which supports the second hypothesis. High anxious pilots experienced a greater decrease in performance anxiety than low anxious pilots which partially supports the fifth hypothesis. This result may have occurred because low anxious pilots have less potential for anxiety reduction and thus a floor as related to the law of initial values may have been an influential factor in these results. Similarly, the data on EMG scores suggest that the biofeedback treatment group experienced a significant reduction in anxiety as measured by a reduction in muscle tension thus supporting the second hypothesis and these results also confirm those of Basmajian (1979). Hypothesis three may have been weakened because the autosuggestive treatment group and the control group did not differ significantly across time in their EMG scores. The greater decrement in anxiety as measured by EMG scores for high anxious pilots compared to low anxious pilots may again be attributed to a floor effect.

The results of analyses of variance of A-Trait scores and EKG scores contradict the research hypotheses in that neither variable indicated a significant reduction in anxiety. Although A-Trait scores produced no significant anxiety change between the three treatment groups over time, this effect might have been anticipated since A-Trait anxiety test purports to measure general feelings rather than specific situational feelings of anxiety. However, there was a slight decrease in mean trait anxiety scores for the biofeedback treatment group while the autosuggestive group remained the same between the pre- and post-tests, and the control group increased slightly between tests, suggesting that EMG biofeedback training did produce a slight trend towards an anxiety decrement but not a statistically significant one.

Analyses of variance of EKG scores did not show a significant difference from pre- to post-test for any of the three treatment groups. This resulted because heart rate is only a general indicator of anxiety and not necessarily a strong predictor of an anxiety state in all situations (Basmajian, 1974). A significant increase in muscle tension as measured by EMG may not necessarily be associated with a corresponding increase in heart rate as measured by EKG (Schwartz and Beatty, 1977). However, the graphs do depict a trend towards a decrease in heart rate between tests for the biofeedback group.

Furthermore, the results on the EKG variable indicated a significant difference between high and low anxiety in both the pre- and post-tests. Therefore, simple effects tests were performed which analyzed interaction at a single point in time rather than a change over time because of the possible floor effect. Also, a drop in heart rate could conceivably be the result of an habituation phenomena between the pre- and post-

test measurements. However, the results from the self-report feedback form (Appendix F) administered to each subject following the treatment programme, suggested in general that the programme was effective in producing an anxiety decrement.

The last two hypotheses proposed that therapeutic intervention would prove successful in producing an improvement in flight performance as measured by timing and flight accuracy as a result of a decrease in performance anxiety, hiqh anxious pilots would show a greater improvement in flight performance as a result of a greater decrease in performance anxiety compared to low anxious pilots.

The failure of the anticipated match between anxiety decrement and performance improvement can be explained in several ways. As discussed earlier, the significant difference between the high and low anxious subjects on the anxiety factor from the pre- and post-tests may be due to a floor effect. Conversely, no statistical significance in flight performance improvement among treatment groups may be the result of a ceiling effect since all subjects were experienced pilots and were already performing at a relatively high degree of proficiency. One of the initial concerns in choosing an experienced group of pilots versus a novice group was to avoid the problems associated with the learning curve. Further scrutiny of the data indicated a trend towards improvement in performance over time for the biofeedback treatment group and the high anxious subjects in both anxiety treatment groups. This observation might be extremely meaningful if a greater sensitivity in assessing performance was employed whereby a closer evaluation of fine motor movements and reaction time may be more acutely observed so that a larger proportion of the variance is attributable to the intervention.

Chapter 5

SUMMARY AND CONCLUSIONS

The primary purpose of this study was to investigate the effectiveness of EMG biofeedback and autogenic training techniques as ways to reduce anxiety and thereby enhance motor performance.

The first phase of the research hypotheses proposed that therapeutic intervention in the form of EMG biofeedback and autogenic training would significantly reduce performance anxiety as experienced by aviation pilots through a flight sequence. The second phase stated that EMG biofeedback and autosuggestive training would cause a significant improvement in flight performance subject to and conditional on a decrease in anxiety.

The hypotheses tested in this study were:

1. Pilots receiving treatment in the form of EMG biofeedback and autosuggestive training would experience an anxiety decrement as measured by state anxiety scores, muscle tension and heart rate as compared to pilots receiving no relaxation training.

2. Pilots receiving EMG biofeedback training would experience a greater anxiety reduction than pilots receiving autogenic training or no treatment (control).

3. Pilots receiving autosuggestive relaxation training would experience a greater anxiety reduction than pilots receiving no treatment.

4. Pilots receiving EMG biofeedback and autogenic training would improve their quality of performance as compared to pilots receiving no relaxation training.

5. High anxious pilots would experience a greater decrement in performance anxiety as measured by state anxiety, EMG and EKG and thus show a greater improvement in performance than low anxious pilots.

A conceptual framework for performance anxiety was developed first. It was proposed to regard anxiety as a hypothetical construct associated with an unpleasant, interfering emotional state recognized by increases in physiological arousal which quite often has a debilitating effect upon motor performance. Secondly, research in the area of anxiety reduction and performance enhancement was reviewed and a high degree of success in this area was attributed to the use of EMG biofeedback and other anxiety reducing techniques.

The subjects of the study were twenty-four male aviation pilots who were blocked on anxiety scores obtained from Spielberger's State Anxiety Inventory and randomly assigned to three treatment groups: Autogenic group, EMG biofeedback group and a control group. Subjects were tested before and after therapy to reduce anxiety on six dependent variables: Spielberger's Trait and State Anxiety Inventories, EMG, EKG and two performance variables (timing and flight accuracy). Performance was assessed by a qualified aviation instructor and rated on two flight performance factors.

The major findings and conclusions of the study were:

(1) Anxiety levels of aviation pilots receiving EMG biofeedback and autosuggestive training were successfully decreased as measured by Spielberger's A-State Anxiety Inventory and electromyographical (EMG)

readings.

(2) Aviation pilots receiving EMG biofeedback training demonstrated a greater reduction in performance anxiety than pilots receiving autosuggestive training or no treatment (control) as measured by Spielberger's A-State Anxiety Inventory and EMG readings.

(3) Aviation pilots receiving **autogenic** training demonstrated a greater reduction in performance anxiety when compared to pilots receiving no treatment as measured by Spielberger's A-State Anxiety Inventory and EMG readings.

(4) Aviation pilots in all treatment groups did not show a significant improvement in the quality of flight performance.

(5) High anxious pilots experienced a greater decrement in performance anxiety as measured by the Spielberger A-State Anxiety Inventory and EMG readings than low anxious pilots; however, no improvement in flight performance was observed.

A number of implications are suggested by this study. It seems evident that therapeutic intervention in the form of EMG biofeedback and autosuggestive relaxation training does produce a significant effect on anxiety reduction in motor performance situations. Since a corresponding improvement in performance did not occur, it was suggested that:

1. The measurement of performance could be made more precise by ensuring that a greater sensitivity in monitoring behavioural differences was taken into account.

2. The experience and proficiency level of subjects may have caused a ceiling effect on the degree of improvement in motor performance since highly skilled performers may not be able to improve significantly.

3. Some concern should be given to the possible habituation phenomena that may occur as a result of single pre- and post-test trials.

Specific recommendations which follow from this study suggest that experimental designs for anxiety-reducing and performance-enhancing studies should take into account individual response variability to anxiety reducing treatments such as time series analysis (Jones, 1977), analysis of variance with large samples, or single case studies with good descriptive reports. Attention should be paid to the dependent measures especially in cases where habituation may confound the treatment effects. It may be necessary to establish multiple baselines (Blanchard, 1974) through the course of the experiment for all physiological variables. If this method is employed, the researcher should be extremely careful to make sure the data is free from electronic artifact.

With respect to measuring performance, it is recommended that monitoring should be sensitive enough to record small increases in performance and individual performance behavior differences should be noted.

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APPENDICES

APPENDIX A

Spielberger's State and Trait Anxiety Inventories

SELF-EVALUATION QUESTIONNAIRE

HOW DO YOU FEEL RIGHT NOW

Name ______________ No. of Minutes/Hours Prior to Performance ________ Date ________

Mark the answer (√) which seems to best describe your feelings - YOUR FEELINGS AT THIS VERY MOMENT.

	Not At All	Somewhat	Moderately So	Very Much So
1. I feel calm	____	____	____	____
2. I feel secure	____	____	____	____
3. I am tense	____	____	____	____
4. I am regretful	____	____	____	____
5. I feel at ease	____	____	____	____
6. I feel upset	____	____	____	____
7. I am presently worrying over possible misfortunes	____	____	____	____
8. I feel rested	____	____	____	____
9. I feel anxious	____	____	____	____
10. I feel comfortable	____	____	____	____
11. I feel self-confident	____	____	____	____
12. I feel nervous	____	____	____	____
13. I am jittery	____	____	____	____

	Not At All	Somewhat	Moderately So	Very Much So
14. I feel high strung	______	______	______	______
15. I am relaxed	______	______	______	______
16. I feel content	______	______	______	______
17. I am worried	______	______	______	______
18. I feel over-excited and 'rattled'	______	______	______	______
19. I feel joyful	______	______	______	______
20. I feel pleasant	______	______	______	______

SELF-EVALUATION QUESTIONNAIRE

HOW DO YOU GENERALLY FEEL

Name ____________ Age ____ Sport ____________ No. of Years Experience ____

Mark the answer (✓) which seems to best describe your general feelings.

		Almost Never	Sometimes	Often	Almost Always
1.	I feel pleasant				
2.	I tire quickly				
3.	I feel like crying				
4.	I wish I could be as happy as others seem to be				
5.	I am losing out on things because I can't make up my mind soon enough				
6.	I feel rested				
7.	I am 'calm, cool and collected'				
8.	I feel that difficulties are piling up so that I cannot overcome them				
9.	I worry too much over something that doesn't really matter ...				
10.	I am happy				

		Almost Never	Sometimes	Often	Almost Always
11.	I am inclined to take things hard	____	____	____	____
12.	I lack self-confidence	____	____	____	____
13.	I feel secure	____	____	____	____
14.	I try to avoid facing a crisis or difficulty	____	____	____	____
15.	I feel blue	____	____	____	____
16.	I am content	____	____	____	____
17.	Some unimportant thought runs through my mind and bothers me	____	____	____	____
18.	I take disappointments so keenly that I can't put them out of my mind	____	____	____	____
19.	I am a steady person	____	____	____	____
20.	I get in a state of tension or turmoil as I think over my recent concerns and interests	____	____	____	____

APPENDIX B

Experimental Design for Data Analysis

Experimental Design for Data Analysis

FACTOR A	FACTOR B	FACTOR C	
Treatment Group	Anxiety Level	Pre-Test (T_1)	Post-Test (T_2)
1. Autosuggestive Training	High Low	Analysis	Variables
2. EMG Biofeedback Training	High Low	Trait State EMG EKG	
3. Control	High Low		Flight Time

APPENDIX C

Aviation Performance Task

Aviation Performance Task

Flight Instructions

"You'll be running against the clock!"

Time (Start - 1 minute)

Do as many preflight checks as you can. You are graded on the number of checks done and their thoroughness.

Time (1 minute - 4 minutes)

Take off on a heading of 360° on the minute.

Climb to an altitude of 1,000 feet.

Maintain an airspeed of 100 knots.

Commence turns at 30° bank from a heading of 360° to 360°.

Alternate left and right turns.

Maintain an airspeed of 100 knots.

You are graded on the number of turns completed. Any manoeuvres above or below limits* are deducted from your overall score.

Time (4 minutes - 6 minutes)

Roll out on your actual heading.

Start descending at 500 feet/minute.

Maintain an airspeed of 100 knots.

Land precisely at the six minute mark.

Every thirty seconds away from the six minute mark either way is one score less.

*Limits ± - 50 feet (elevation)　5 knots (airspeed)
50 (banks)　5° (heading)

APPENDIX D

Aviation Pilot Stress Reduction Study Questionnaire Form

Aviation Pilot Stress Reduction Study

PERSONAL DATA BASE
(Confidential)

Date: ____________________ Student No. ______________

Name: ______________________________

Local Address: ______________________

____

Local Phone: ______________________

Permanent Mailing Address: ______________________________________

____

Birth Date: ______________________

General Health Related Disorders (i.e., Backaches, low back pain, muscle/joint aches, headaches, skin rashes, stomach problems, diarrhea, etc.):

____

____

Medication Used: ____

Nutritional Habits (Salt, sugar intake, etc.) ____________________

____

Description of Activity Level: __________________________________

____

Major Stressors/Pressures Currently: _____________________________

____

Motivation Level for Treatment/Changes: __________________________

____

Areas of Concern: ____

APPENDIX E

EMG Training Chart

EMG Training Chart

Microvolt Level				
Date:				
Time Period:				
Muscle(s):				
Feedback:				

APPENDIX F

Feedback Form

Feedback Form

1. Answer each of the following questions either YES or NO.

    (a) Sessions were meaningful? ___

    (b) Sessions were relevant? ___

    (c) Sessions were helpful? ___

    (d) The programme was effective? ___

2. Do you feel the research director was effective in administering stress reduction treatment? (Yes or No) ___

3. Do you feel generally less anxious now than you did when the programme first began? (Yes or No) ___

    Comments: ______________________________

    ____

4. Do you feel specifically less anxious about flying now than you did when the programme first began? (Yes or No) ___

    Comments: ______________________________

    ____

5. Do you feel that your flying has improved as a direct result of the programme? (Yes or No) ___

    Comments: ______________________________

    ____

APPENDIX G

Raw Score Values on Pre-Test and

Post-Test Dependent Variables

Table 14

RAW SCORE VALUES ON PRETEST VARIABLES
TRAIT STATE AND EMG SCORES

GROUP	ID	TRAIT	STATE	EMG1	EMG2	EMG3	EMG4	EMG5	EMG6	EMG7	EMG8	EMG9	EMG10	EMG11	EMG12	EMG13	EMG14
AUTO SUGGEST																	
	1	58.0	68.0	4.0	4.4	5.6	5.8	6.4	7.2	7.2	7.5	6.8	6.0	6.0	5.5	5.3	5.2
	2	38.0	50.0	3.2	3.6	4.0	4.2	4.8	4.2	4.4	4.6	4.4	4.6	5.0	5.2	5.4	5.6
	3	46.0	57.0	5.8	5.8	6.2	6.2	6.4	6.5	6.2	6.2	6.2	6.0	5.8	5.0	5.2	5.2
	4	38.0	55.0	3.8	3.8	4.8	4.8	4.8	4.6	4.7	4.7	4.5	4.8	4.8	4.8	4.8	4.8
	5	30.0	30.0	2.8	2.9	3.0	3.4	3.4	3.2	3.4	3.6	3.7	3.2	3.0	2.8	2.8	2.8
	6	32.0	35.0	7.0	7.6	8.0	8.8	9.0	9.6	9.6	9.8	9.8	9.6	9.8	9.7	9.6	9.4
	7	37.0	42.0	3.1	3.0	3.4	3.6	3.8	4.0	4.2	4.4	4.4	4.8	4.8	3.0	3.0	3.0
	8	37.0	41.0	3.0	3.0	3.2	3.4	3.4	3.6	3.7	3.6	3.8	3.8	3.6	3.8	3.8	3.6
MEAN		39.5	47.2	4.1	4.3	4.8	5.0	5.2	5.4	5.4	5.5	5.4	5.3	5.3	5.0	5.0	4.9
BIOFEEDBACK																	
	1	39.0	62.0	4.2	4.4	5.0	5.8	5.8	6.8	6.9	7.0	8.0	8.2	8.6	8.4	8.8	8.8
	2	38.0	55.0	4.0	4.0	4.6	4.8	4.8	5.8	5.8	6.4	6.8	6.6	6.9	7.2	7.6	7.7
	3	46.0	57.0	5.2	5.5	6.1	6.3	6.0	5.2	6.8	6.7	6.6	6.5	7.0	7.2	7.6	7.2
	4	46.0	56.0	7.8	7.7	8.1	8.2	8.4	8.0	7.8	7.8	8.4	8.6	8.1	8.0	7.4	7.3
	5	31.0	24.0	4.4	4.2	4.8	5.0	5.4	5.5	4.0	4.2	4.0	4.2	4.8	4.2	4.6	4.4
	6	35.0	39.0	5.2	5.6	4.8	4.6	4.2	5.6	6.0	6.2	7.2	7.1	6.8	6.6	6.4	6.5
	7	31.0	44.0	3.0	3.2	3.8	3.8	4.0	4.2	4.4	4.4	4.8	4.8	5.0	4.0	4.2	4.0
	8	30.0	41.0	3.2	3.6	3.8	3.8	3.8	4.0	4.4	4.8	4.9	5.2	4.5	4.2	4.0	3.8
MEAN		37.0	47.2	4.6	4.8	5.1	5.3	5.3	5.6	5.8	5.9	6.3	6.4	6.5	6.2	6.3	6.2
CONTROL																	
	1	49.0	61.0	3.4	3.8	4.0	4.6	4.4	4.8	4.9	5.0	5.2	5.3	6.1	5.2	4.8	4.8
	2	40.0	60.0	6.0	6.2	6.4	8.0	8.2	8.3	8.4	8.6	8.8	8.6	7.8	7.7	7.2	7.6
	3	46.0	58.0	5.2	5.6	5.8	6.0	6.2	6.4	6.6	6.8	6.8	6.4	6.2	5.0	5.0	5.0
	4	42.0	50.0	3.0	3.1	3.2	3.8	3.9	4.0	3.8	3.9	3.8	4.0	4.2	3.8	3.6	3.8
	5	32.0	31.0	2.8	2.9	2.8	3.0	3.4	3.2	3.3	3.4	3.5	3.6	3.5	3.5	3.5	3.5
	6	34.0	36.0	5.0	5.8	6.8	6.6	6.8	6.8	6.7	5.9	5.9	5.8	5.5	5.0	5.0	5.0
	7	33.0	42.0	3.2	3.2	3.6	3.6	3.8	3.6	3.4	3.8	3.8	3.8	3.2	3.2	3.2	3.2
	8	33.0	40.0	3.6	3.0	3.8	4.2	4.8	4.8	4.8	5.2	5.5	4.8	4.6	4.0	4.0	3.5
MEAN		38.6	47.2	4.0	4.2	4.5	5.0	5.2	5.2	5.2	5.3	5.4	5.3	5.1	4.7	4.5	4.5

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'EKG TIME AND FLY SCORES'/

Table 15

RAW SCORE VALUES ON PRETEST VARIABLES
EKG TIME AND FLY SCORES

GROUP	ID	EKG1	EKG2	EKG3	EKG4	EKG5	EKG6	EKG7	EKG8	EKG9	EKG10	EKG11	EKG12	EKG13	EKG14	TIME	FLY
AUTO SUGGEST																	
	1	98	98	105	110	112	118	124	124	126	130	132	138	137	135	6	7
	2	84	86	90	94	94	96	96	98	99	102	104	108	100	100	7	7
	3	98	96	94	98	96	98	98	97	96	97	88	86	84	80	7	7
	4	78	74	78	82	86	88	89	90	92	92	96	94	98	98	5	5
	5	57	58	60	62	64	66	68	69	80	82	62	64	68	64	7	7
	6	121	126	128	134	132	136	131	132	132	130	133	134	130	128	6	7
	7	82	86	88	90	96	98	98	88	88	82	82	78	77	70	8	7
	8	64	68	68	66	64	72	78	88	88	86	83	80	78	76	6	7
MEAN		85.2	86.5	88.9	92.0	93.0	96.5	97.7	98.2	100.1	100.1	97.5	97.7	96.5	93.9	6.5	6.5
BIOFEEDBACK																	
	1	108	110	115	115	120	122	124	132	138	136	128	128	130	132	6	7
	2	110	112	116	118	116	122	128	138	135	126	125	125	125	120	6	7
	3	94	98	108	100	114	116	112	116	120	112	110	108	92	90	5	6
	4	69	76	78	86	84	85	88	100	102	78	76	76	74	74	7	8
	5	75	75	82	88	86	87	74	76	77	88	86	90	96	98	6	8
	6	68	66	69	72	80	84	88	100	86	78	79	82	84	81	7	7
	7	78	77	80	86	88	100	110	112	116	102	102	96	90	82	7	7
	8	72	74	78	78	86	88	96	98	112	104	102	96	94	88	7	7
MEAN		84.2	86.0	90.7	92.9	96.7	100.5	102.5	109.0	110.7	103.0	101.0	100.1	98.1	95.6	6.4	6.8
CONTROL																	
	1	77	76	77	84	88	90	92	88	86	84	84	80	82	82	6	7
	2	106	112	124	126	128	129	127	128	130	128	112	116	114	110	5	5
	3	94	100	110	112	114	120	118	118	120	118	100	92	91	88	7	7
	4	82	84	86	88	82	97	96	98	98	95	96	94	92	92	6	6
	5	67	67	68	68	74	78	77	82	82	81	80	74	74	68	7	8
	6	110	112	118	122	124	124	128	128	126	118	116	110	112	112	8	6
	7	96	96	104	108	108	106	104	108	108	98	98	96	94	94	7	6
	8	84	85	98	94	92	92	94	96	112	94	96	90	88	84	5	7
MEAN		89.5	91.5	98.1	100.2	101.2	104.5	104.5	105.7	107.7	102.0	97.7	94.0	93.4	91.2	6.4	6.5

Table 16

RAW SCORE VALUES ON POSTTEST VARIABLES
TRAIT STATE AND EMG SCORES

GROUP	ID	TRAIT	STATE	EMG1	EMG2	EMG3	EMG4	EMG5	EMG6	EMG7	EMG8	EMG9	EMG10	EMG11	EMG12	EMG13	EMG14
AUTO SUGGEST																	
	1	56.0	64.0	3.5	3.5	4.4	4.4	4.8	4.8	5.0	5.2	5.2	5.5	5.2	5.2	5.0	4.8
	2	38.0	45.0	4.0	4.2	4.6	4.4	4.8	4.7	4.6	4.5	4.2	4.3	4.4	4.4	4.8	4.6
	3	47.0	55.0	4.8	5.2	5.5	5.8	5.8	6.2	6.4	6.4	6.0	5.5	5.4	5.4	5.4	5.0
	4	39.0	45.0	3.8	3.8	3.6	4.4	5.0	5.2	5.5	5.4	5.5	5.2	5.2	5.0	5.0	5.1
	5	32.0	30.0	2.8	2.8	3.2	3.2	3.2	3.4	3.4	3.6	3.6	3.2	3.2	3.4	3.8	3.5
	6	32.0	32.0	7.0	7.0	7.7	7.7	7.8	8.8	8.9	9.4	9.6	9.9	9.4	9.6	9.4	9.7
	7	37.0	37.0	3.0	3.0	3.8	3.8	3.4	3.8	3.7	3.6	3.5	3.8	3.5	3.6	3.4	3.4
	8	37.0	39.0	3.4	3.2	3.6	3.6	3.8	3.6	3.9	3.4	3.4	3.2	3.2	3.0	3.0	3.0
MEAN		39.7	43.4	4.0	4.1	4.5	4.7	4.8	5.1	5.2	5.2	5.1	5.1	4.9	4.9	5.0	4.9
BIOFEEDBACK																	
	1	38.0	52.0	3.4	3.4	4.1	4.0	4.4	4.8	5.0	5.0	4.8	4.4	4.0	4.0	3.8	3.8
	2	32.0	42.0	3.0	3.2	3.4	3.8	3.8	4.0	4.2	4.0	3.8	3.8	3.4	3.2	3.2	3.0
	3	44.0	55.0	4.0	4.0	4.2	4.4	4.6	4.6	4.8	5.0	5.2	5.2	4.8	4.4	4.4	4.2
	4	45.0	51.0	3.5	3.5	4.4	4.6	4.8	5.5	5.5	5.5	5.2	5.2	4.6	4.8	4.6	4.0
	5	30.0	24.0	3.0	3.0	3.5	3.5	3.2	3.2	3.4	3.3	3.7	3.6	3.4	3.5	3.5	3.5
	6	30.0	32.0	3.0	3.2	3.4	3.4	3.8	3.8	4.0	3.6	3.6	3.4	3.2	3.4	3.2	3.2
	7	32.0	34.0	2.6	2.6	3.0	3.0	3.2	3.4	3.4	3.6	3.2	3.2	3.3	3.4	3.0	3.2
	8	31.0	34.0	2.7	2.8	2.8	3.2	3.4	3.4	3.6	3.5	3.8	3.7	3.0	3.2	3.2	3.0
MEAN		35.2	40.5	3.1	3.2	3.6	3.7	3.9	4.1	4.2	4.2	4.2	4.1	3.7	3.7	3.6	3.5
CONTROL																	
	1	48.0	62.0	3.2	3.2	4.1	4.2	4.8	5.0	5.5	5.2	5.5	5.3	5.3	5.0	4.4	4.6
	2	38.0	58.0	5.8	6.0	6.6	7.8	8.6	8.6	8.6	8.6	8.4	8.0	8.0	8.0	8.0	7.8
	3	47.0	56.0	4.8	4.8	5.5	5.5	5.8	6.4	6.4	6.6	6.8	5.5	5.5	5.2	5.2	5.2
	4	42.0	54.0	2.8	3.2	3.6	3.6	4.2	4.4	4.2	4.6	3.8	3.6	3.6	3.2	3.3	3.4
	5	32.0	30.0	3.0	3.2	3.4	3.4	3.8	3.6	3.6	3.8	3.7	3.6	3.6	3.5	3.5	3.6
	6	37.0	38.0	3.8	4.6	4.6	4.8	4.4	4.8	4.8	5.0	5.2	5.5	5.5	5.5	5.0	5.2
	7	36.0	45.0	4.2	4.0	4.2	4.4	4.0	4.0	3.8	3.8	4.0	3.4	3.4	3.2	3.0	3.0
	8	32.0	38.0	3.2	3.2	3.4	3.6	3.5	4.2	4.2	4.6	4.8	4.8	4.2	4.6	3.7	3.7
MEAN		39.0	47.6	3.8	4.0	4.4	4.7	4.9	5.1	5.1	5.3	5.3	5.0	4.9	4.8	4.5	4.6

Table 17

RAW SCORE VALUES ON POSTTEST VARIABLES
EKG TIME AND FLY SCORES

GROUP	ID	EKG1	EKG2	EKG3	EKG4	EKG5	EKG6	EKG7	EKG8	EKG9	EKG10	EKG11	EKG12	EKG13	EKG14	TIME	FLY
AUTO SUGGEST																	
	1	78	76	92	94	98	96	110	118	120	126	126	120	124	125	5	7
	2	80	80	82	84	85	88	90	92	94	98	98	89	93	93	7	7
	3	94	96	96	96	92	90	90	94	94	89	89	86	88	84	8	7
	4	84	82	88	86	90	94	96	98	99	97	82	84	82	80	5	7
	5	58	58	62	66	64	66	68	69	75	75	68	68	68	68	7	7
	6	128	132	134	136	138	140	137	136	140	137	132	134	120	124	6	7
	7	76	74	78	83	82	88	88	94	96	87	86	88	82	78	7	7
	8	72	74	76	86	88	84	82	88	90	94	88	86	84	84	7	7
MEAN		83.7	84.0	88.5	91.4	92.1	93.2	95.1	98.6	101.0	100.4	96.1	94.4	92.6	92.0	6.5	6.7
BIOFEEDBACK																	
	1	88	86	89	96	98	108	110	116	116	104	108	110	112	112	7	7
	2	100	104	108	109	118	116	118	120	118	116	116	110	112	110	7	7
	3	88	89	92	94	94	108	110	104	97	96	98	89	88	86	5	7
	4	77	77	86	88	88	96	98	98	82	84	86	84	79	79	7	7
	5	72	72	78	78	76	77	86	82	88	80	78	74	74	72	7	7
	6	76	76	82	82	84	86	88	88	96	98	94	90	84	79	8	7
	7	68	70	72	72	78	90	96	98	108	104	100	98	90	86	7	7
	8	74	74	77	78	80	82	86	86	92	95	98	96	82	80	7	8
MEAN		80.4	81.0	85.5	87.1	89.5	95.4	99.0	99.0	99.6	97.1	97.2	93.9	90.1	88.0	6.9	7.0
CONTROL																	
	1	80	84	86	88	92	94	88	94	96	88	78	78	80	82	6	7
	2	110	110	122	132	130	130	128	130	126	110	108	108	110	106	5	6
	3	106	108	110	118	118	120	120	124	122	110	108	98	90	90	7	6
	4	72	77	80	84	84	90	90	96	96	94	94	96	90	98	6	6
	5	66	68	90	92	94	96	88	86	84	82	84	84	78	76	8	7
	6	103	100	112	118	120	122	124	128	126	122	124	118	116	112	7	7
	7	88	90	98	98	104	108	110	114	112	114	115	110	105	106	6	6
	8	99	90	92	95	97	88	86	86	94	92	90	90	94	92	6	7
MEAN		90.5	90.9	98.7	103.1	104.9	106.0	104.2	107.2	107.0	101.5	100.1	97.7	95.4	95.2	6.4	6.5

APPENDIX H

Analysis of Variance Summaries for EMG Training Data

Table 18

Summary of Analysis of Variance (Autosuggestion)

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F	p
S - Within	11.98	7	1.71		
A (Probe)	0.00	2	0.00	0.11	0.90
AS - Within	0.02	14	0.01		
B (Time)	6.15	5	1.23	31.32	0.01
BS - Within	1.38	35	0.04		
AB	0.10	10	0.01	0.92	0.52
ABS - Within	0.07	70	0.01		

Table 19

Summary of Analysis of Variance (Biofeedback)

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F	p
S - Within	4.16	7	0.59		
A (Probe)	0.89	2	0.45	39.68	0.01
AS - Within	0.16	14	0.01		
B (Time)	35.20	5	7.04	79.84	0.01
BS - Within	3.09	35	0.09		
AB	0.09	10	0.10	1.82	0.07
ABS - Within	0.35	70	0.01		

Table 20

Summary of Analysis of Variance (Control)

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F	p
S - Within	3.96	7	0.57		
A (Probe)	0.00	2	0.00	0.58	0.57
AS - Within	0.00	14	0.00		
B (Time)	1.23	5	0.25	12.98	0.01
BS - Within	0.66	35	0.02		
AB	0.01	10	0.00	0.49	0.89
ABS - Within	0.01	70	0.00		

APPENDIX I

Graphed Profiles of Mean Group Physiological Responses Throughout the Flight Sequence Over Time

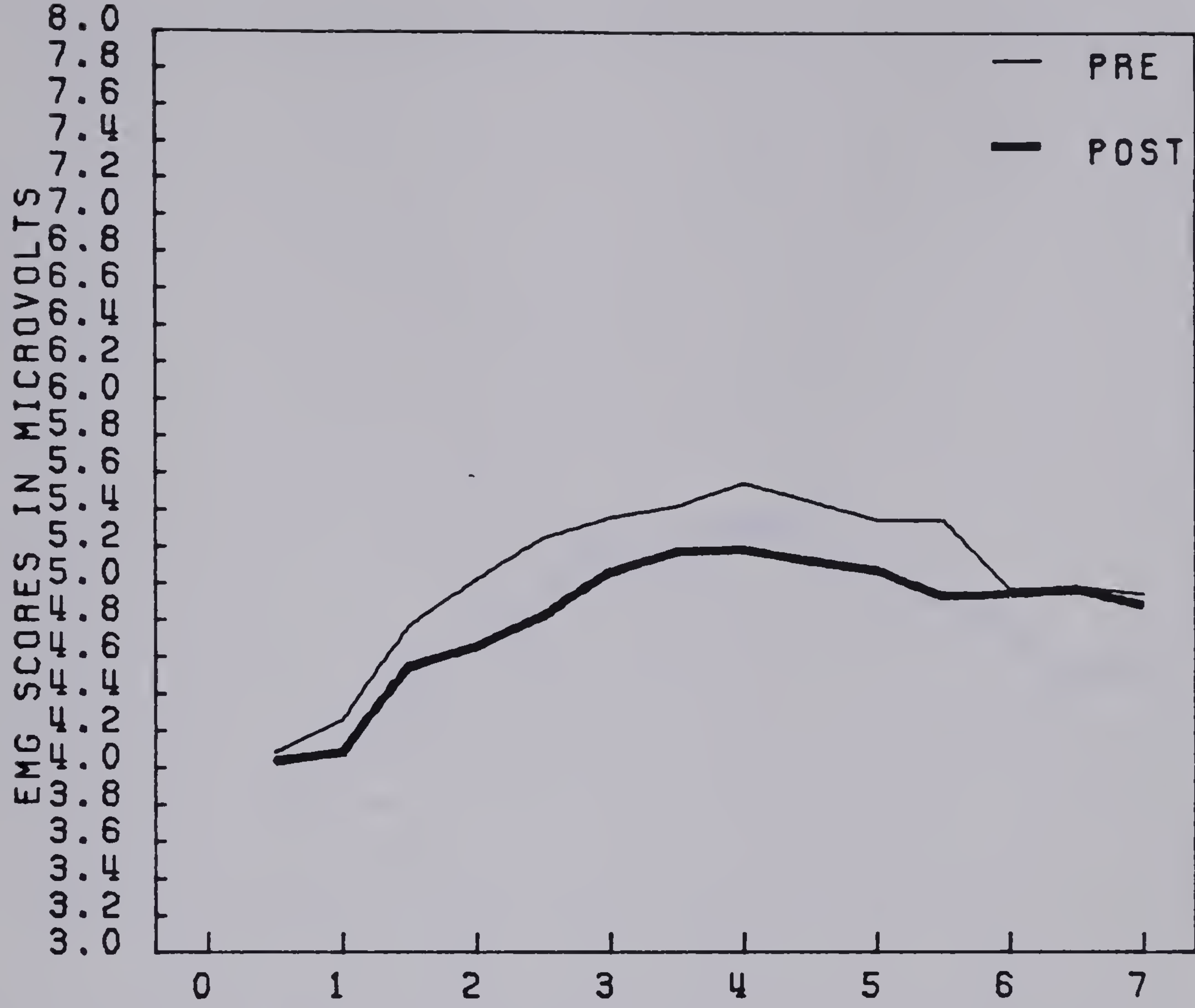

Figure 16. Mean pre and post EMG for autogenic groups.

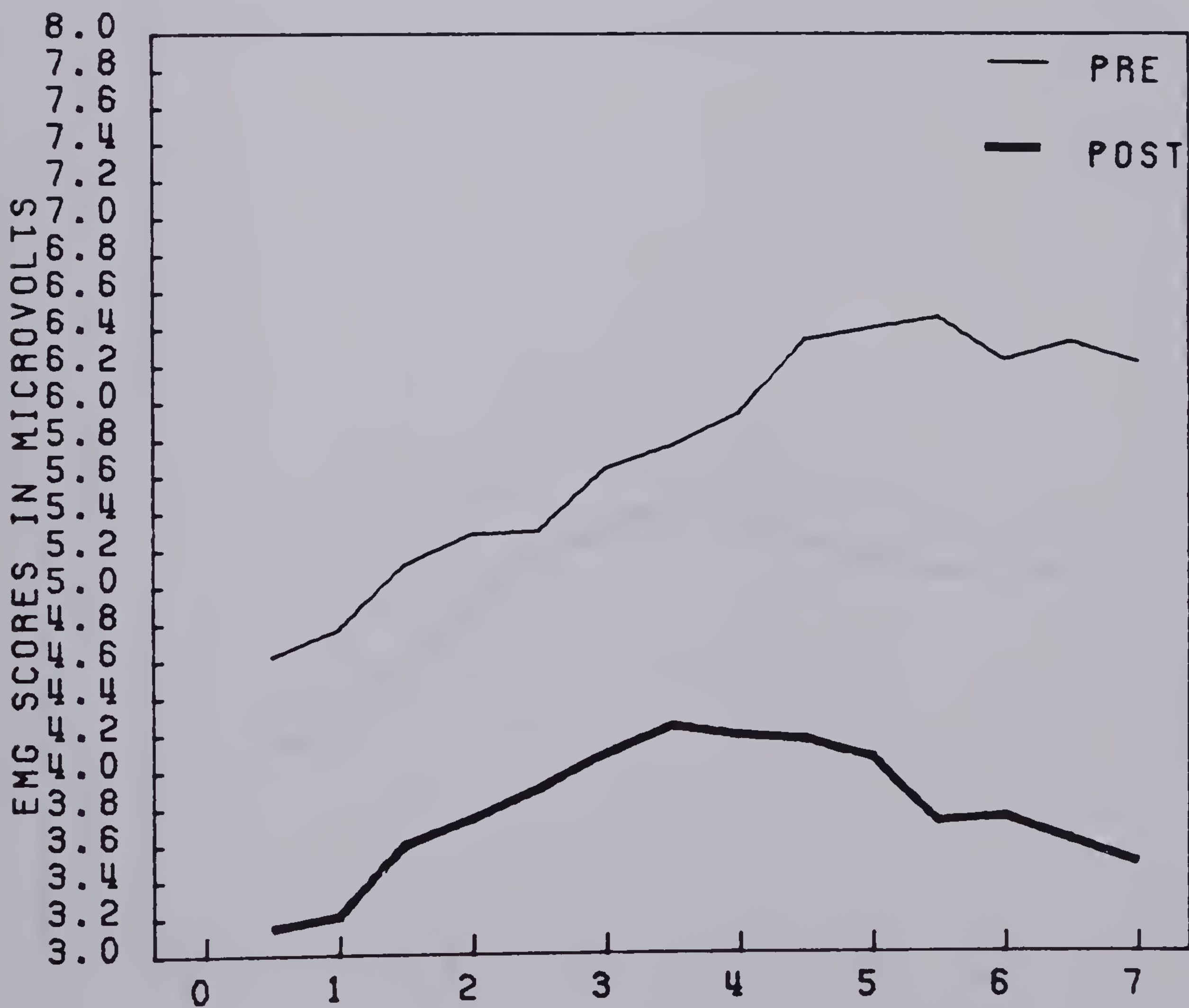

Figure 17. Mean pre and post EMG for biofeedback group.

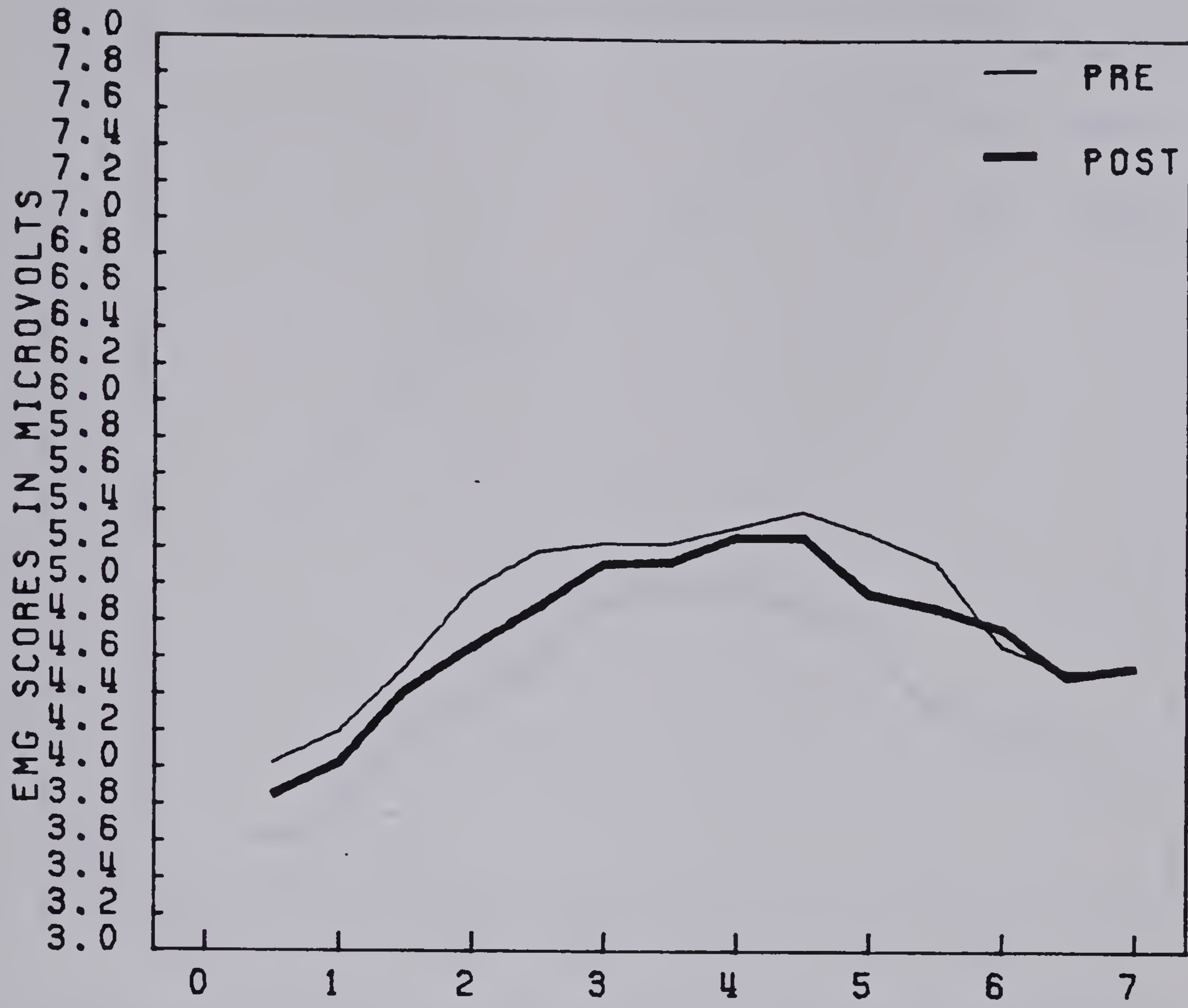

Figure 18. Mean pre and post EMG for control group.

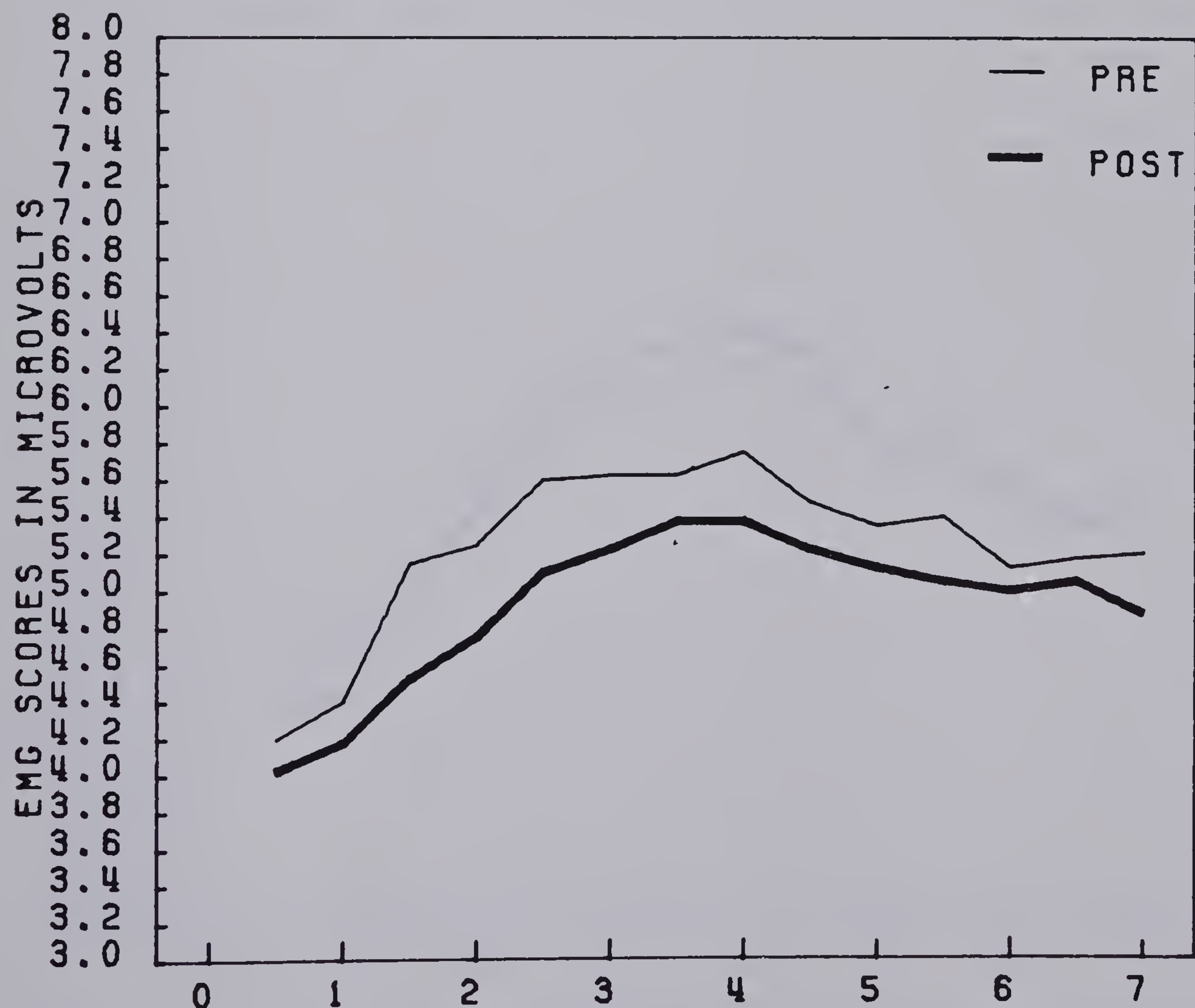

Figure 19. Mean pre and post EMG for high anxious autogenic group.

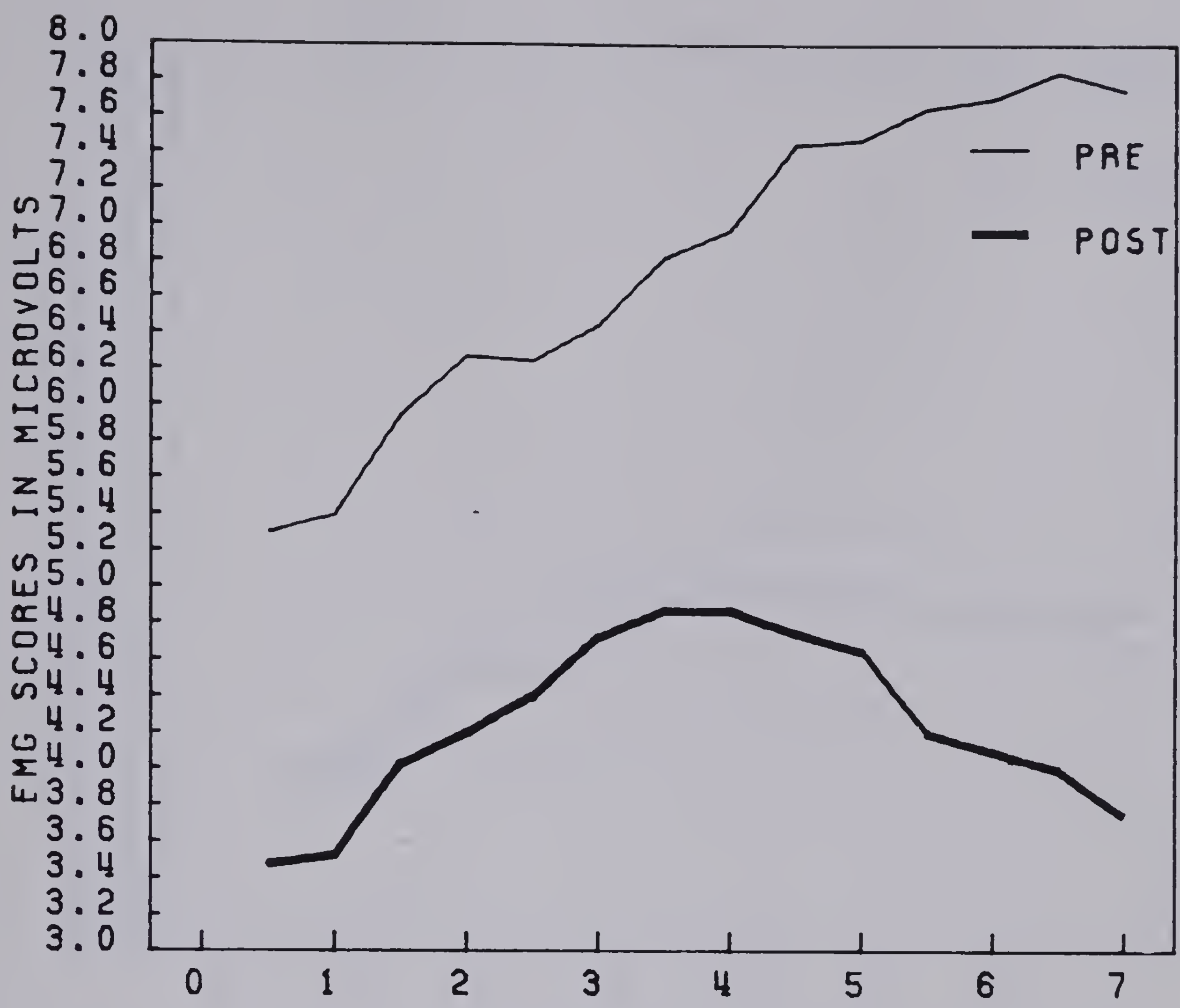

Figure 20. Mean pre and post EMG for high anxious biofeedback group.

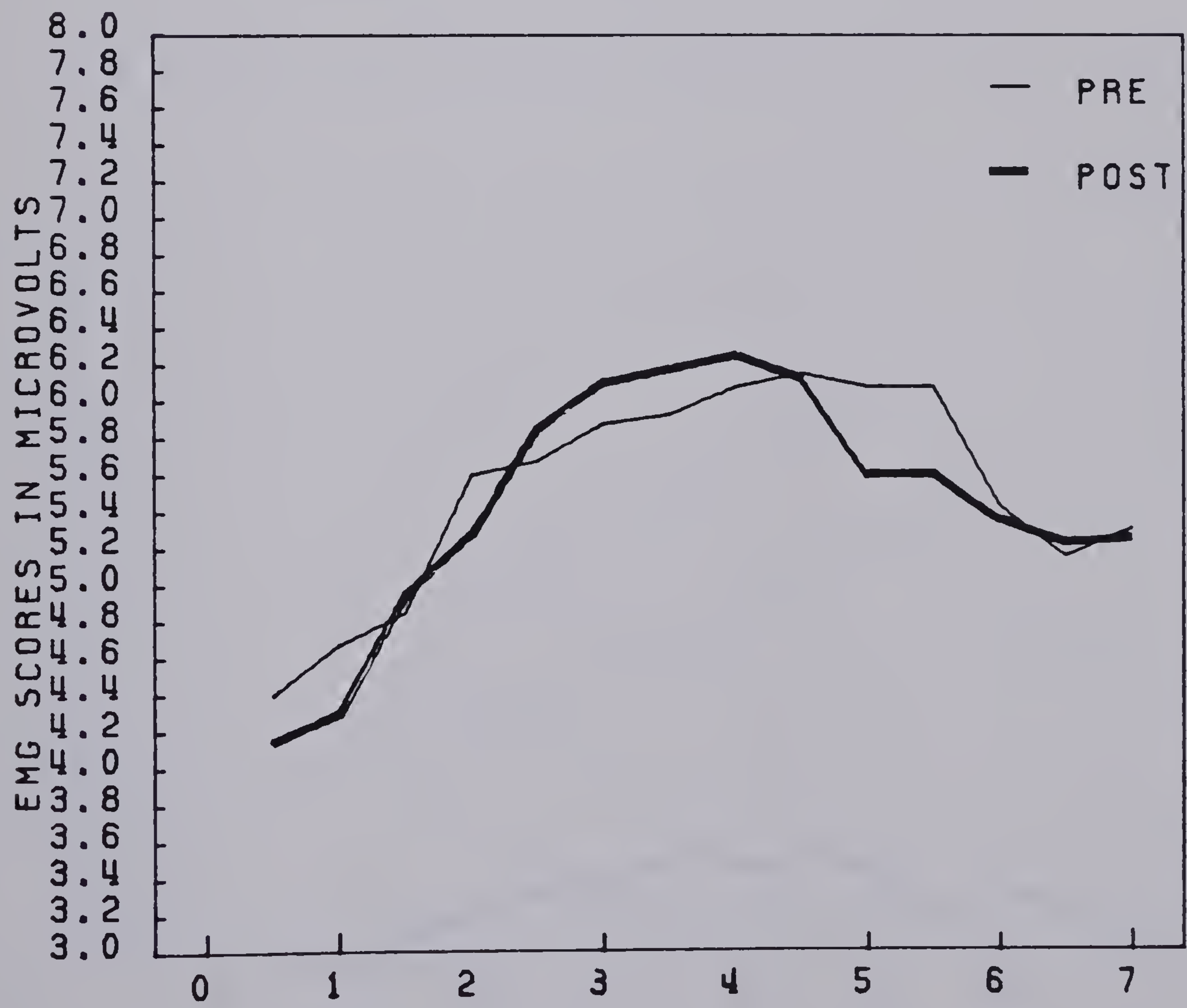

Figure 21. Mean pre and post EMG for high anxious control group.

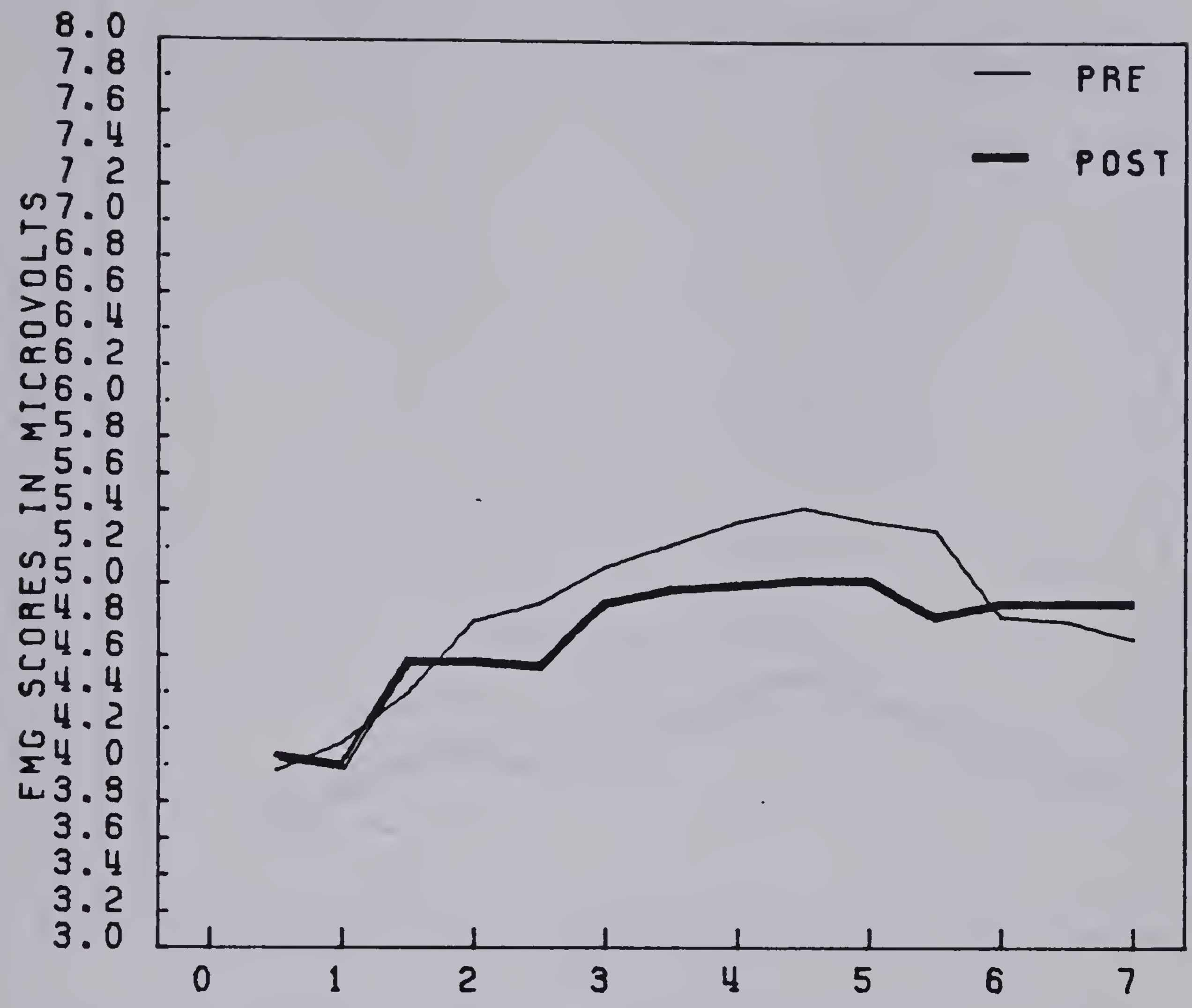

Figure 22. Mean pre and post EMG for low anxious autogenic group.

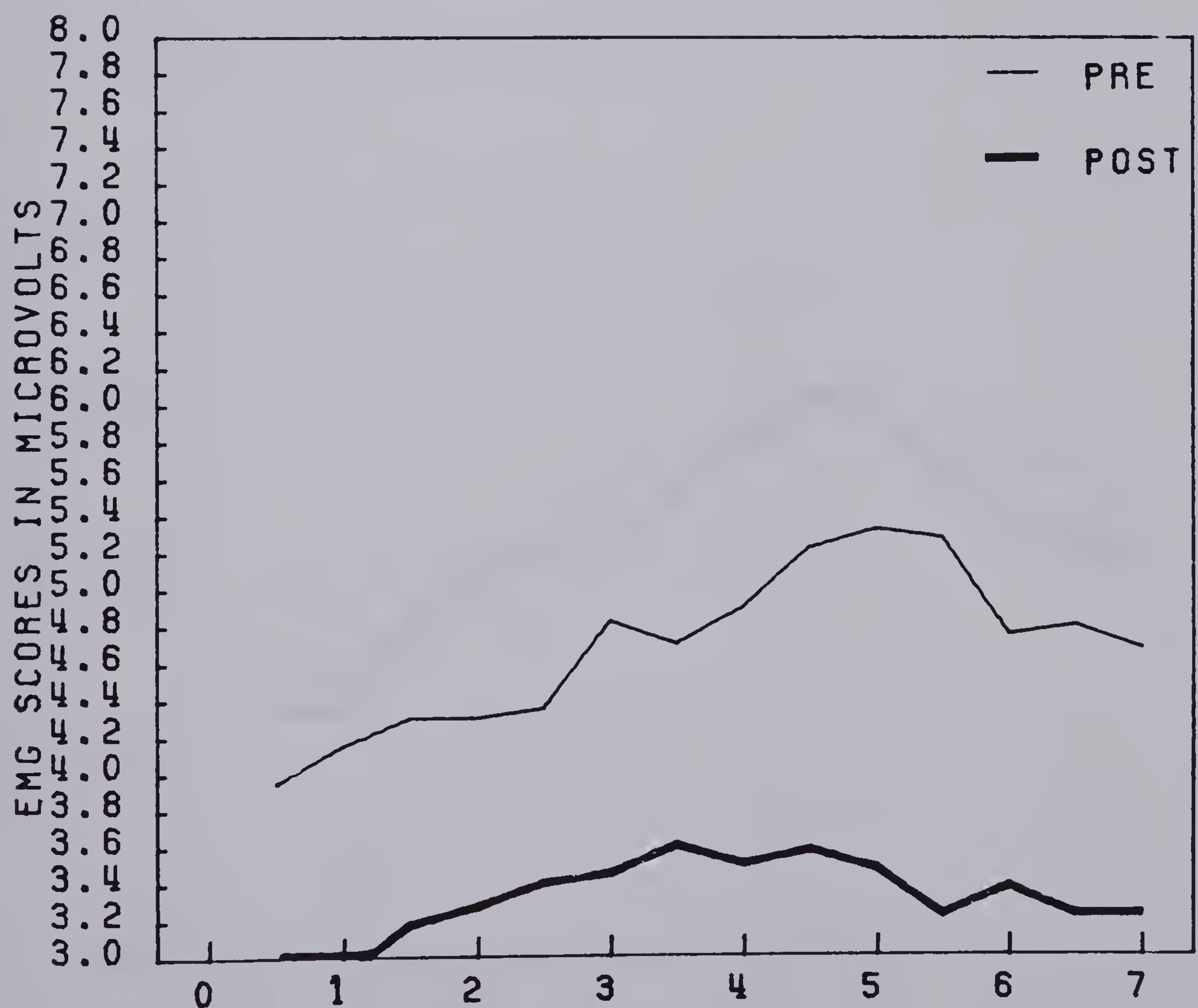

Figure 23. Mean pre and post EMG for low anxious biofeedback group.

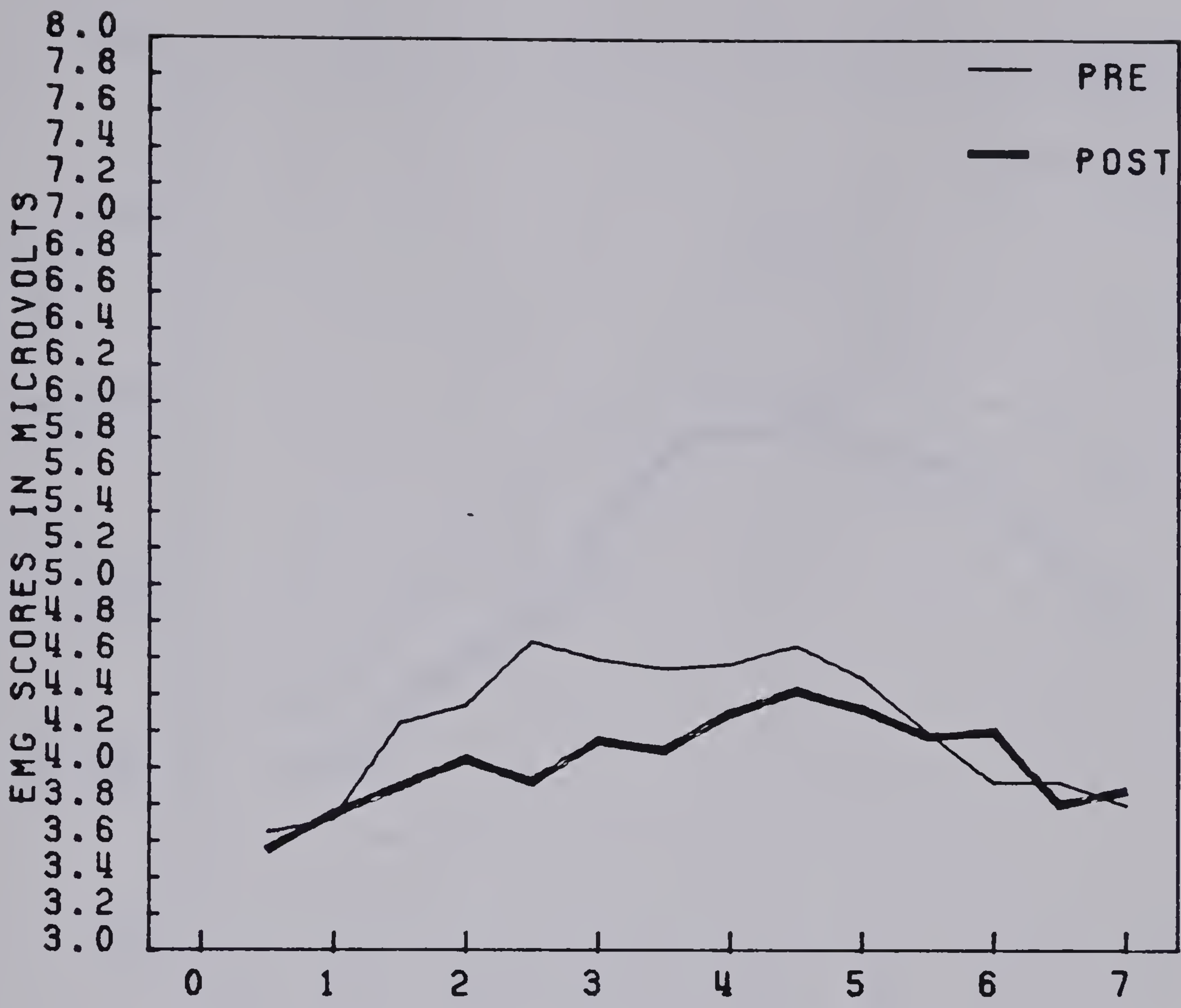

Figure 24. Mean pre and post EMG for low anxious control group.

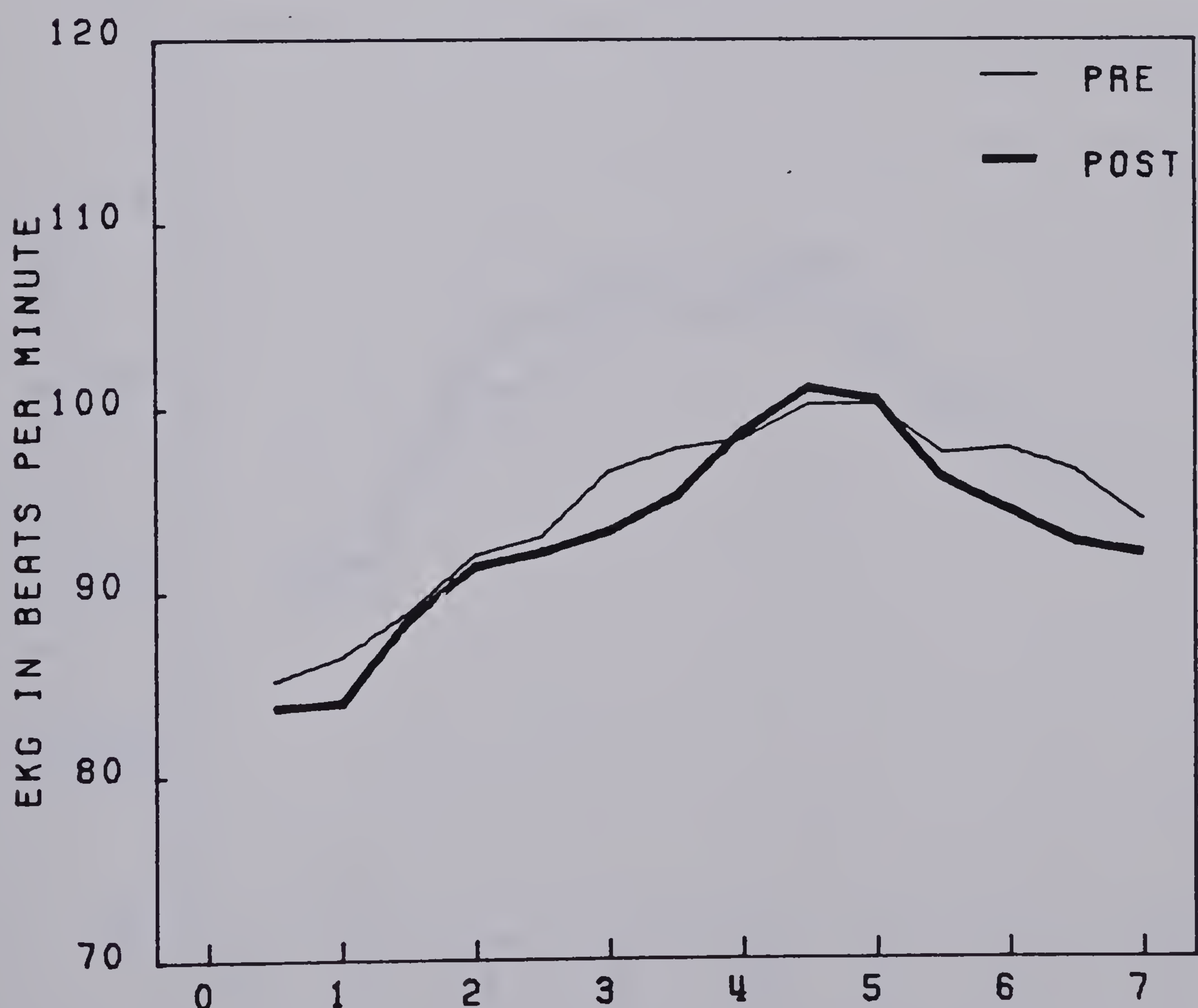

Figure 25. Mean pre and post EKG for autogenic group.

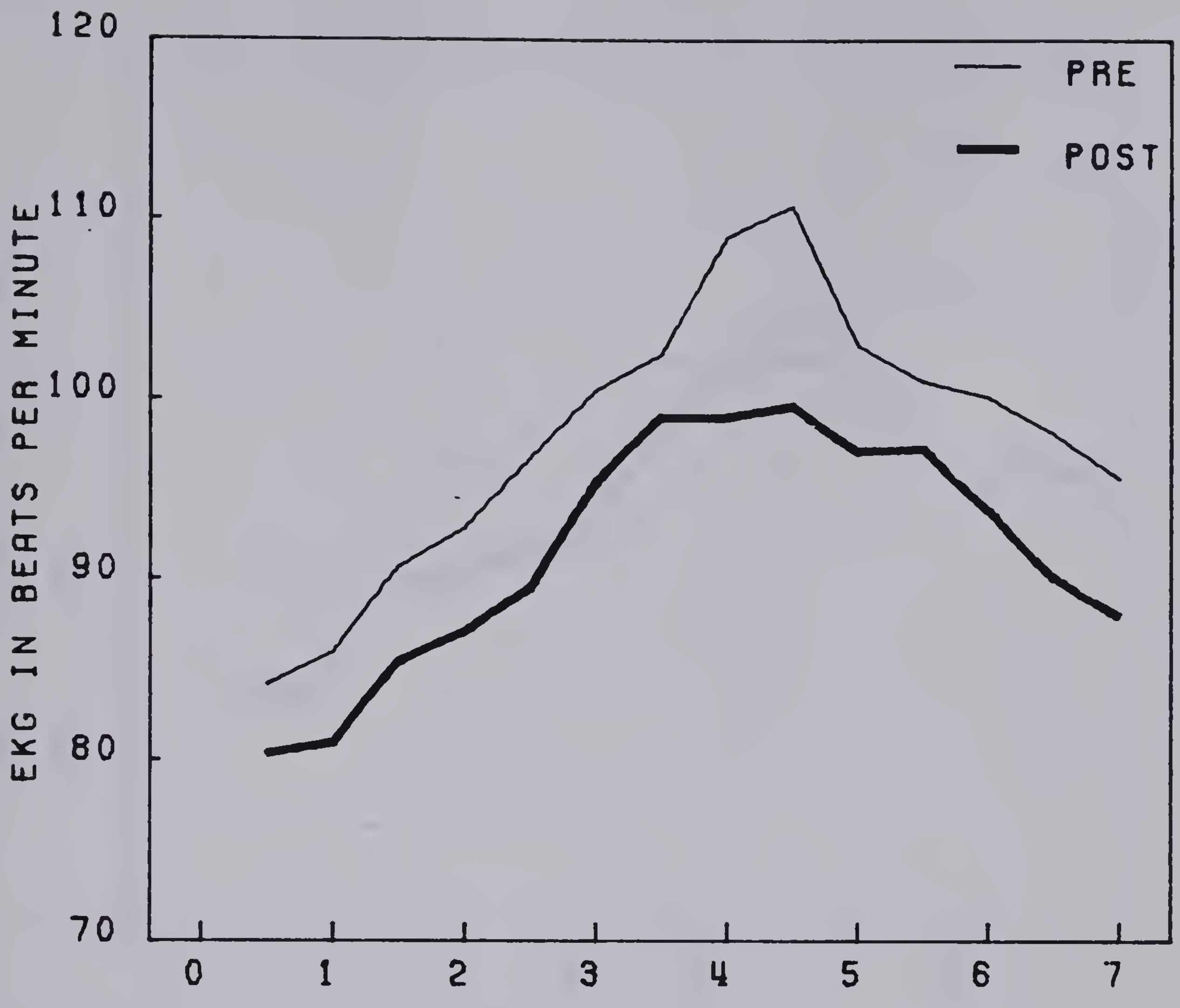

Figure 26. Mean pre and post EKG for biofeedback group.

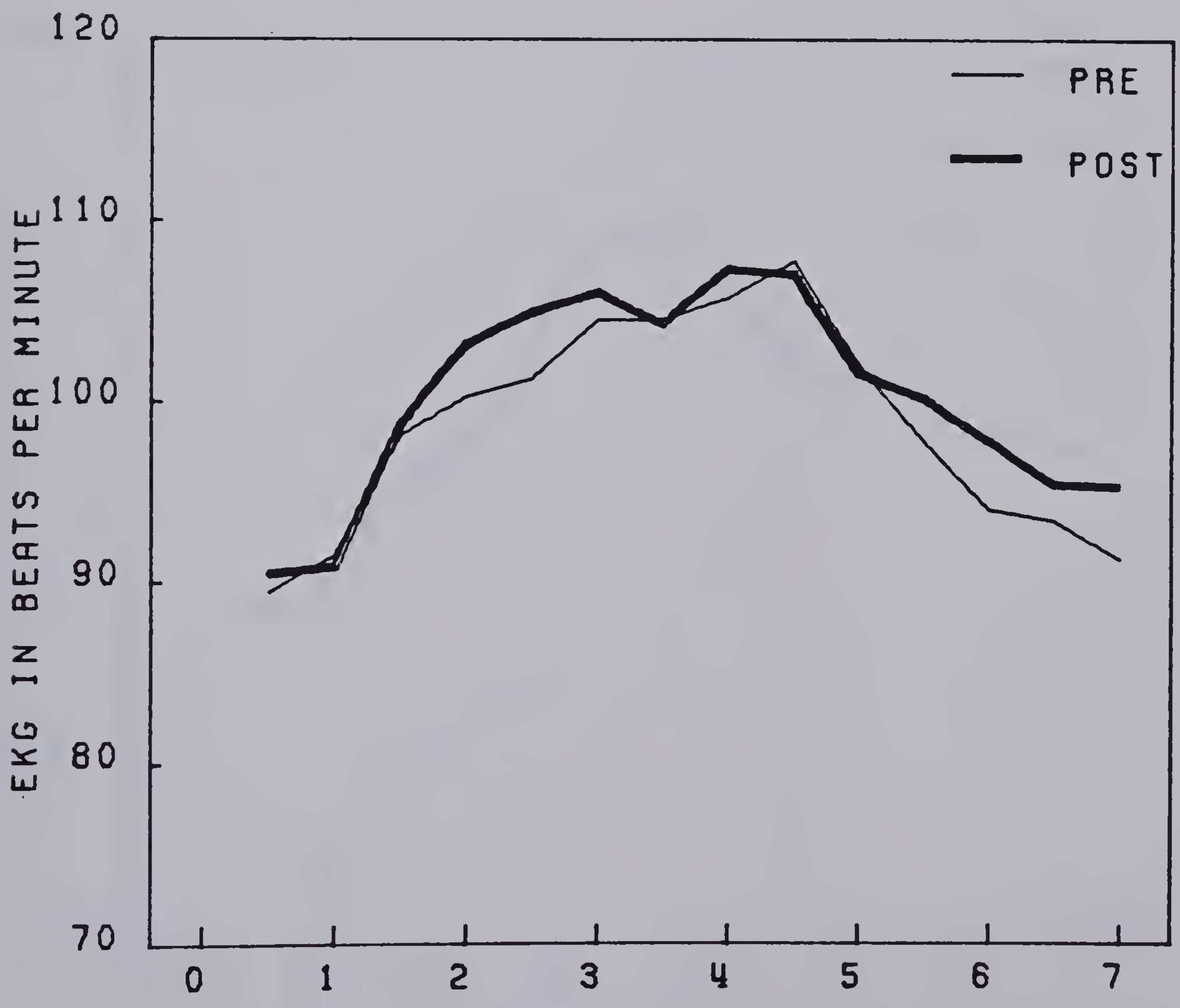

Figure 27. Mean pre and post EKG for control group.

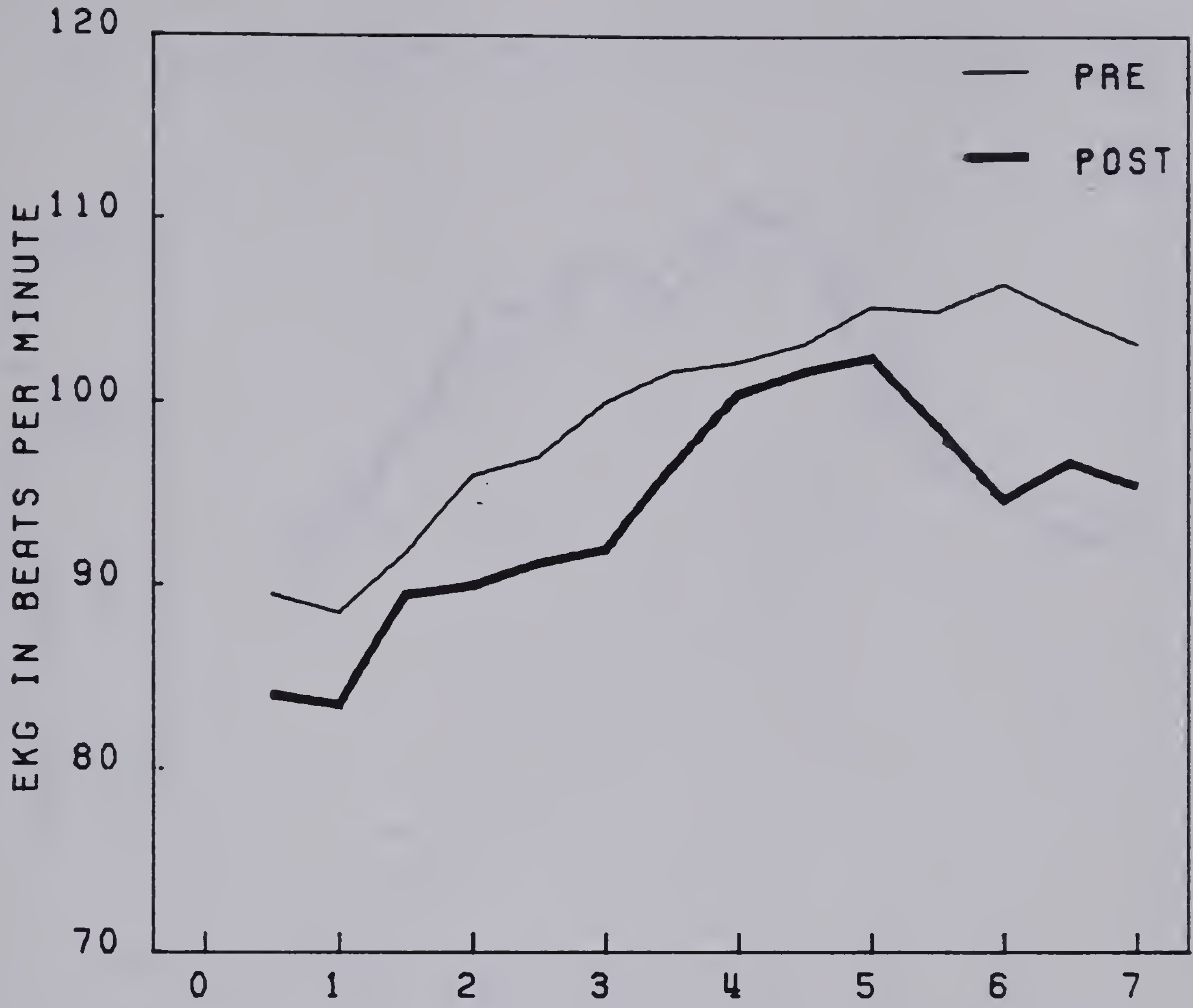

Figure 28. Mean pre and post EKG for high anxious autogenic group.

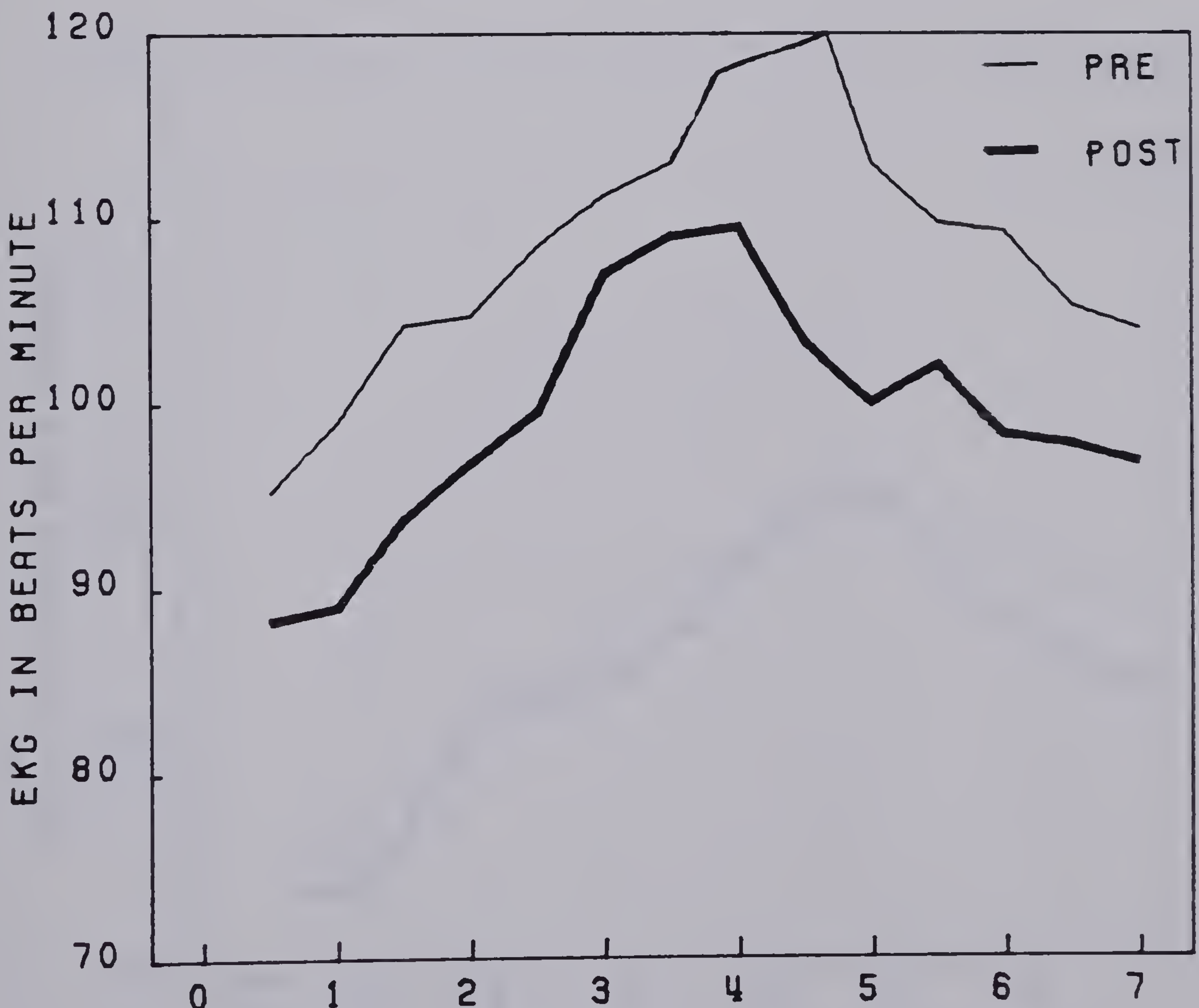

Figure 29. Mean pre and post EKG for high anxious biofeedback group.

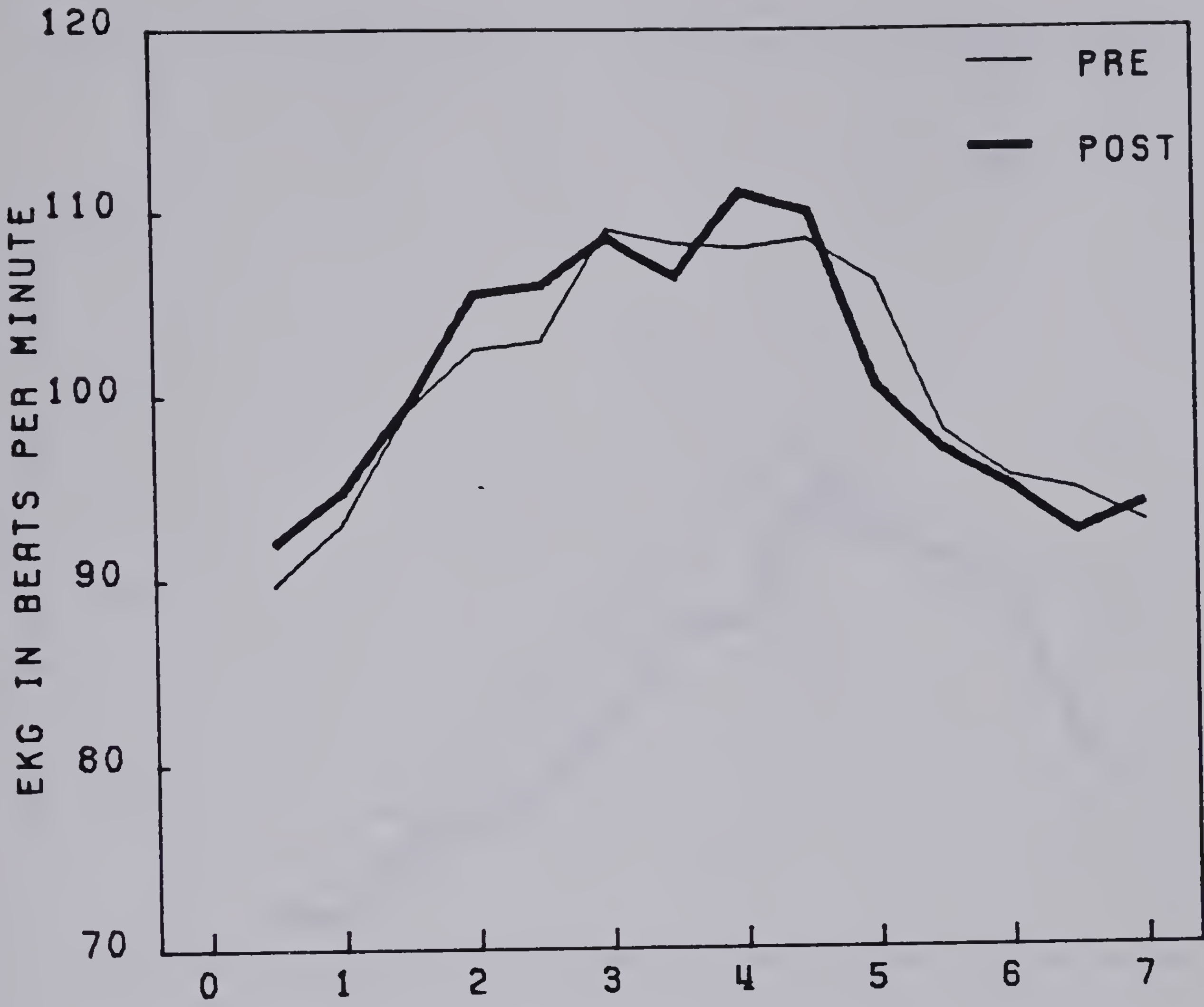

Figure 30. Mean pre and post EKG for high anxious control group.

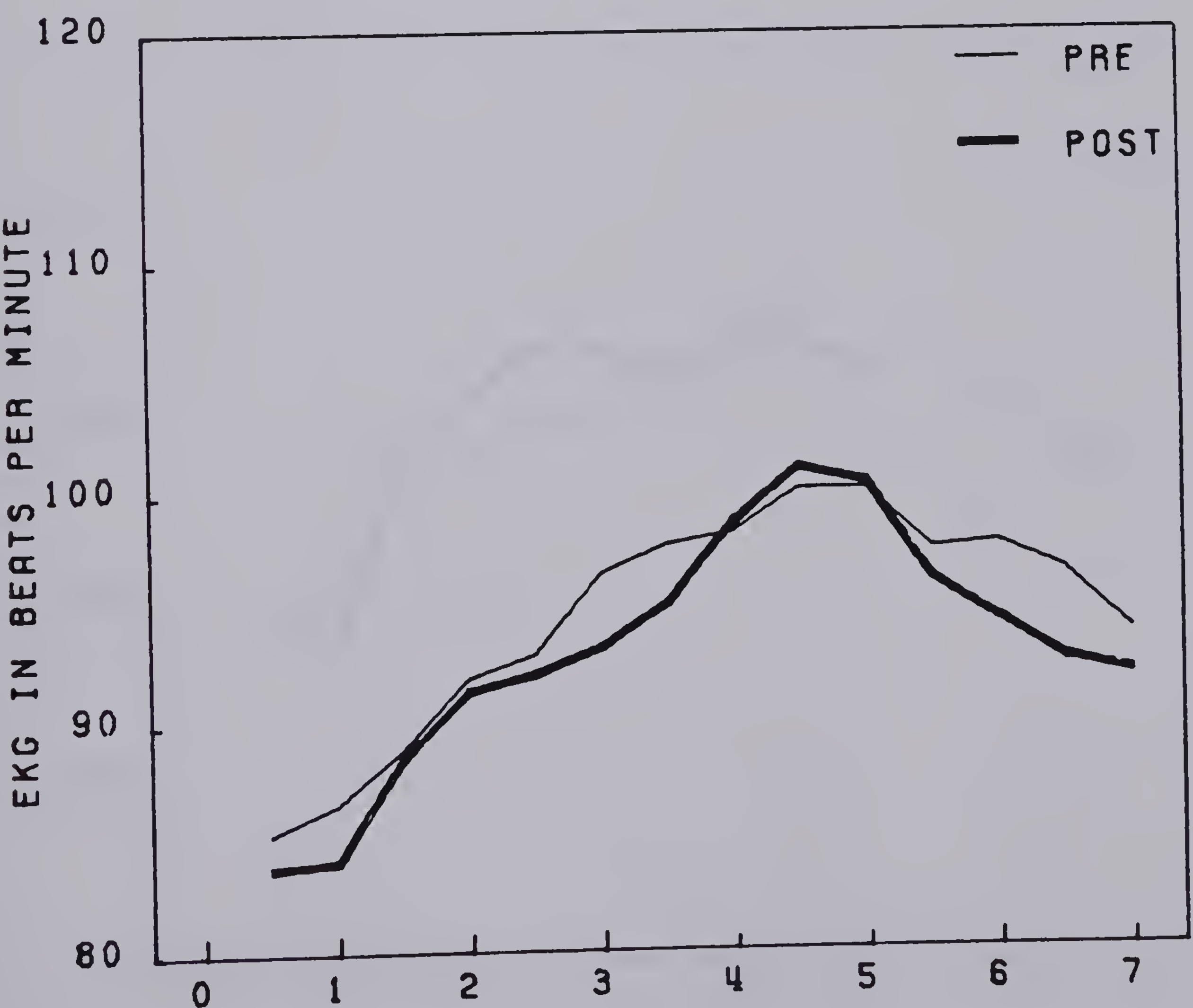

Figure 31. Mean pre and post EKG for autogenic group.

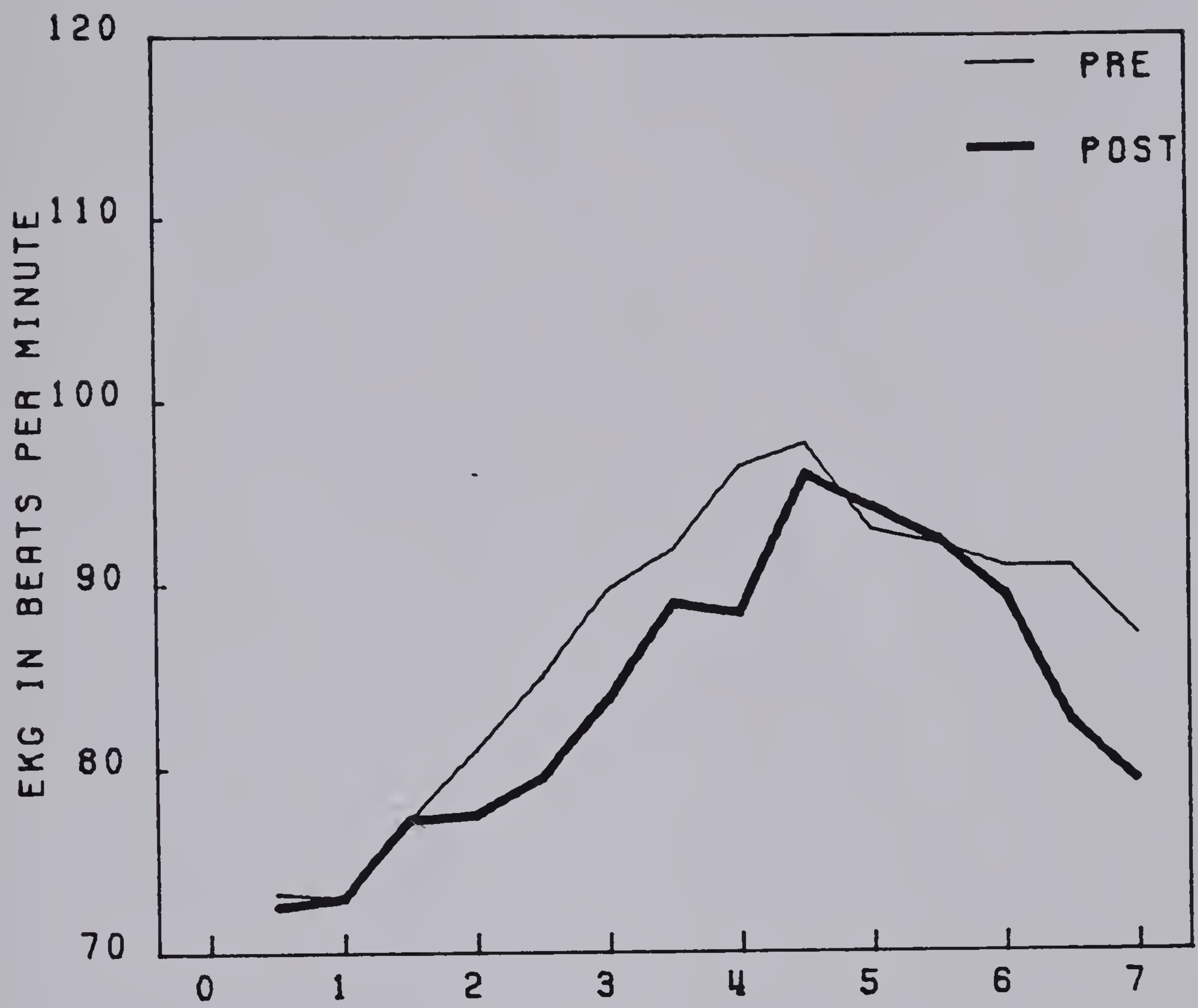

Figure 32. Mean pre and post EKG for low anxious biofeedback group.

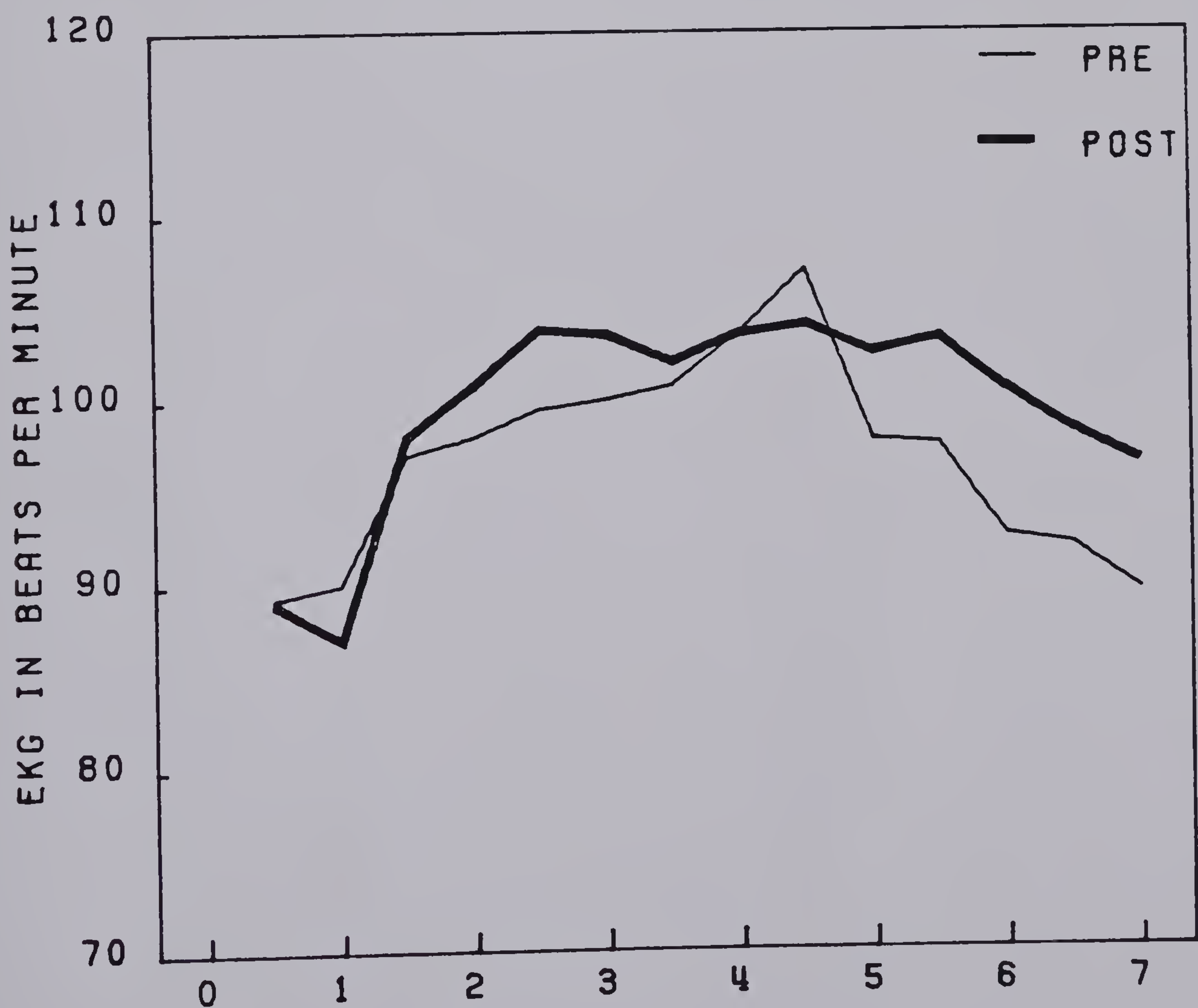

Figure 33. Mean pre and post EKG for low anxious control group.